TELECOM BUSINESS REVIEW

A Journal of Symbiosis Institute of Telecom Management

ISSN: 0973-9114

SYMBIOSIS INSTITUTE OF TELECOM MANAGEMENT

Volume 10 Issue 1 SEPTEMBER 2017

TELECOM BUSINESS REVIEW

Editorial Message

It gives me immense pleasure in presenting to you the tenth issue of Telecom Business Review Journal (TBR Journal 2017). The TBR Journal has been a platform for scholars, teachers, professionals and students to contribute and showcase their knowledge, research, experience, study results and findings in the relevant areas of Technology, Business and Management. In the TBR September 2016 Issue, we published articles on diverse topics such as , "Profitable Solution to Emerging Market Challenges Through 'Internet of Things", "Implicit Testing- An Improved way of testing software", "Decoding DA-Vinci Code: TMMI Assessment Model Revisited", "Telecom-OTT partnership – Generating New Revenue sharing models", "Valuation Techniques in Telecommunication Industry- an Alternative Approach based on Operating Cash Flow and Number of Subscribers", "Literature Review of Service Failure, Service Recovery and their effects on Consumers and Service Employees".

I am sure this year's issue of the TBR Journal 2017 will also help to trigger quality studies in the field of Telecom Business Management and enlighten and educate the Telecom fraternity.

At the release of the tenth issue, I thank all the contributors for their thought provoking articles. I also express my heartfelt gratitude to the members of the Editorial Review Board and all our esteemed reviewers. I also seek the support of the telecom fraternity in our efforts of making the TBR Journal global by contributing research papers that highlight global issues in telecom business.

Prof. Abhijit Chirputkar
Director SITM

Telecom Business Review

Volume 10 Issue 1 September 2017

ISSN: 0973-9114

Contents

Journal is available online at www.publishingindia.com

Article can be accessed online at http://www.publishingindia.com

A Study of Personality Traits, viz., Extraversion and Introversion on Telecommuters' Burnout

Rahil Meymandpour*, Zahra Bagheri**

**Ph.D. Student, Department of Management Sciences, Savitribai Phule Pune University, Pune, Maharashtra, India. Email: meymandpour.rahil@yahoo.com,*

***Associate Professor, Department of Biostatistics, Shiraz University of Medical Sciences, Shiraz, Iran. Email: bagherizb@gmail.com*

Abstract

In this study with regard to employees' personality types, namely, extroverts and introverts based on Jung's typology Model, it is targeted to demonstrate which group has more congruencies to the features of telecommuting to experience less burnout result from the qualities of this type of workplace. Besides, the model of this study is inspired by person-environment fit theory. The samples were 86 females and 130 males from Ministry of Cooperatives, Labour and Social Welfare of Iran. The teleworking burnout and personality questionnaires with 28 statements for gathering data; in addition, SPSS 16 and Lisrel 8.8 for descriptive and inferential statistics were applied. From given data, it was obvious there was a correlation between extraversion and burnout with correlation rate of 0.55, whereas introversion had zero effect on burnout with correlation rate of -0.13. It can be concluded introverted employees can face stresses resulting from telecommunication more easily than extroverted ones regarding differences between these two characteristics.

Keywords: Extraversion-Introversion Personality Traits, Telecommunication, Burnout

1. Introduction

The extended services usage of informative technology and its effect on human's life in various ways is an avowed phenomenon (Amiel & Sargent, 2004). Social interaction through the Internet has more benefits than traditional one (Bargh & McKenna, 2004), so the function of telecommunication has increased (Useem & Harington, 2000) enabling employees to have a remote office work (Herschel & Andrews, 1997), called 'telecommuting', coined by Jack Nilles in 1973 (Nilles, Carlson, Gray & Hanneman, 1976). Whereas anybody designated to telecommute has not the capability of doing so (Novaco & Gonzalez, 2009). It might be a well-chosen professional for individuals who cannot declare themselves in face to face interaction (Amichai-Hamburger & Ben-Artzi, 2000; McKenna, Green & Gleason, 2002). Moreover the effect of personality characteristics on work-related outcomes is an escapable phenomenon (George, 1992). Then employers can find the suited-personality employees to telework, being independent on social interactions in workplace (Moss & Carey, 1994). From the point of view of personality, it can be either extrovert or introvert one (Jung, 1971). The former type is sociable, seeks more companionships and extrinsic opportunities to interact and being with others. While the latter type prefers one's own companionship, doesn't enjoy large social events and is seen as quiet and remote individual (Eysenck & Eysenck, 1975). Verily, employers should assess employee's suitability to recruit adaptable one for such a remote work (Whitehead, 1999) which has features like employees' less informal interactions (Ellison, 1999) and no face to face contact with the addressee resulting in outcomes such as the feeling of being in the highly protective milieu (Hamburger & Ben-Artzi, 2000) and role ambiguity leading to job stressors (Martino & Wirth, 1990). So these job characteristics and stressors bring about employee's burnout (Van den Broeck, Vansteenkiste, De Witte & Lens, 2008).

Burnout is defined as a chronic response to emotional and interpersonal stressors (Maslach, Schaufeli & Leiter, 2001). So employees should carry an especial personality to handle the features of telecommuting. Individual characteristics can affect telecommuting practices and adoption (Peters, Tijdens & Wetzels, 2001). In the context of a research problem, it is worthwhile to investigate whether personality styles; extraversion and introversion can have significant effects on the employees' teleworking burnout. In the following related works are inquired to find a proper answer.

2. Brief Literature Review

However, some works consider telecommuting as a coping strategy reducing job stressors (Hartig, Kylin & Johansson, 2007), telecommuting features as stated previously bring about outcomes leading to job stressors and eventually burnout (Van den et al., 2008). Negative responses from personality to working environments lead to stress. As respects, Lewin (1951) is the first pioneer having research about mutual interaction between person and environment leading to positive/negative responses. Other scientists formalize this notion into the person-environment fit model in which they argue the mismatch between person and work environment impressing his/her health resulting in stress (French, 1973), chronically burnout; as some theories find personality characteristics and job environments can be factors leading to burnout (Ivacovides, Fountoulakis, Kaprinis, & Kaprinis, 2003).

Besides, Peters et al. (2001) assert in their study that desire for a quiet job environment is a significant feature affecting telecommuting outcomes. According to this telecommuting feature and all stated before and also characteristics in introverts and extroverts, some scholars such as Whitehead (1999) and Blau and Barak (2012) emphasize introverts are the suited ones to unsocial jobs in which they can find their hereditary isolation, while they would be uninspired jobs for their extroverted counterparts. Simmons (1996) also implies teleworking requires a naturally introverted employee. In her work Hannay (2016) explains introverted individuals are more suited to teleworking than extroverted ones since social isolation in telecommuting fits introversion personality.

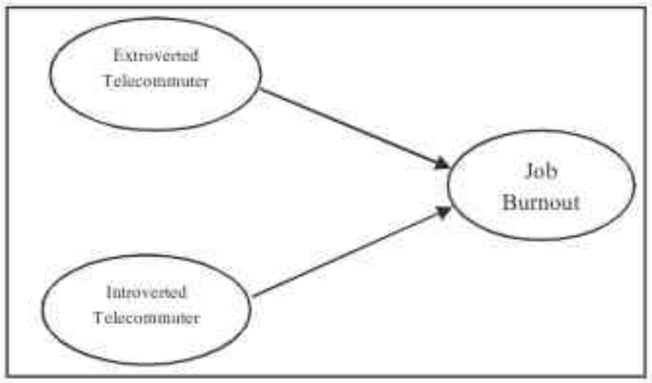


Fig. 1: Theoretical Model of this Study

Through previous studies it can be inferred introversion personality fits telecommuting workplace due to matching between introverted individuals' characteristics and teleworking features. So in this paper, Jung's (1971) personality typology including extraversion and introversion can touch on this issue. Additionally, the basis of present model is the theory of person-environment fit (French, 1973) in which job outcomes influenced under the matches between personality types and job settings. Thus any mismatches lead to job stressors and eventually burnout which is the discussing issue in this study targeted to test the impacts of personality types, viz., extraversion and introversion, based on Jung's personality typology (1971), on telecommuters' burnout. The theoretical model of this research is shown in the following diagram:

3. Objective

In this paper it is aimed to aver whether introversion has negative relationship with burnout. As it is seen from the diagram-1 it is hypothesized in the studied model both extroverted and introverted personalities would bring about burnout to prove which one would not. So the questions in this paper can be:

- Has extraversion positive relationship with teleworking burnout?
- Has introversion positive relationship with teleworking burnout?

4. Research Methodology

In this correlation study, the statistical population is selected based on judgment sampling method from Ministry of Cooperatives, Labour and Social Welfare of Iran which is the first organization in Iran set telecommuting as the remote part-time job setting for its employees. The sample size is calculated through NCSS/PASS software being 216 cases including 86 females and 130 males.

To reach the objective of this study and to prove the hypotheses; the secondary data was collected from books, articles and e-journals and the primary data was collected through researchers' observation, and the informal discussion was also done with those employees about the drawbacks and benefits of telecommuting setting which were the low-speed Internet, family problem, not being oriented with IT, loosing self-confidence in workplace, etc. as the drawbacks and having more time for dealing with personal and work affairs, getting familiar with IT application, solving commuting disorders, etc. as benefits. Moreover, the two 5-point Likert scaled questionnaires were applied including:

Teleworking burnout questionnaire derived from job burnout inventory (Maslach & Jackson, 1981) with frequency and intensity of 0.89 and 0.86, 0.77 and 0.72, and the 0.74 and 0.74 for three subscales, viz., emotional exhaustion, depersonalization, and job inefficacy, respectively, constituting 12 statements (each subscale constitutes 4 statements). The attained Cronbach's alpha of teleworking burnout is 0.96.

Personality questionnaire derived from the Eysenck personality questionnaire (EPQ) (Eysenck & Eysenck, 1975) with average reliability of 0.86 for male and female in extra-intro scale (Eysenck, Eysenck & Barrett, 1985) and extensive consensus concerning the validity of most versions of Eysenck's personality inventory/questionnaire such as Wilson and Doolabh's study (1992) possesses acceptable one. In the present study the personality questionnaire is conducted two traits; extraversion and introversion with the consideration of 8 statements for anyone. The alpha is 0.93 for extraversion and the same figure for introversion.

Categorical confirmatory factor analysis (CCFA) was used to evaluate the structure validity of the studied questionnaires. Several criteria were used to assess goodness of fit, including chi-square statistics, root mean square error of approximation (RMSEA), Tuker-Lewise index (TLI), and comparative fit index (CFI). Nonsignificant values of chi-square test (chi-square value can be significant at 0.1 level then it can be interpreted variables have relationship with each other), values of CFI and TLI≥0.95, and RMSEA≤0.08 can support acceptable model fit since Hu and Bentler (1995) imply TLI value is usually lower than CFI meanwhile values more than 0.90 or 0.95 are considered acceptable. However, chi-square statistics detects even trivial differences under large sample size (Cheung & Rensvold, 2002); in this study the other above-mentioned indices were used as well. The Mean- and Variance-adjusted Weighted Least Square (WLSMV) estimation procedure in the LISREL software was used to perform the CCFA.

The values of fit indices (RMSEA, CFI, and TLI) for the CCFA in Table-1 indicate one-factor model for burnout questionnaire and introversion and extroversion questionnaires fit the data well (RMSEAs<0.10, CFIs≥0.0.98, and TLIs≥0.97) which confirm the construct validity of all questionnaires.

The descriptive statistics through SPSS 16 is used for correlation between three variables. Moreover, for testing the studied model, structural equation modeling (SEM) through Lisrel 8.54 is used.

Table 1: Goodness of Fit Indices for Assessing Structure Validity

Factor	*Goodness of fit indices*			
	$\chi 2$(df)*	CFI	TLI	RMSEA
burn out	312.4(54)	0.99	0.98	0.10
Extraversion	62.52(20)	0.99	0.98	0.09
Introversion	99.9(20)	0.98	0.97	0.11

*χ^2 is significant at 0.1 Level

5. FINDINGS

The significance of relationship between three variables is attained through the correlations resulted from descriptive statistics as shown in Table 2:

Table 2: Pearson Correlations of Three Variables N=216

Raw	*Variables*	*1*	*2*	*3*
1	Burnout	-		
2	Extraversion	0.59**	-	
3	Introversion	-0.42**	-0.58**	-

** Correlation is significant at the 0.01 level

As it is seen in Table-2 three variables have significant correlation at the 0.01 level. Actually, burnout and extraversion have positive relationship between each other while introversion has negative relationship with two others.

Figure obtained through SEM is offered in the diagram-2:

It can be said from the diagram-2 the results achieved from SEM to test the model is the same as the results of descriptive statistics, means there is direct relationship between burnout and extroversion meanwhile there is inverse relationship between burnout and introversion.

There is fit statistics achieved from SEM to prove the significance of tested model. Actually, the values of fit indices showed the model fit the data well so the hypothesized model is correct. The following table is fit statistics and the optimal cut points:

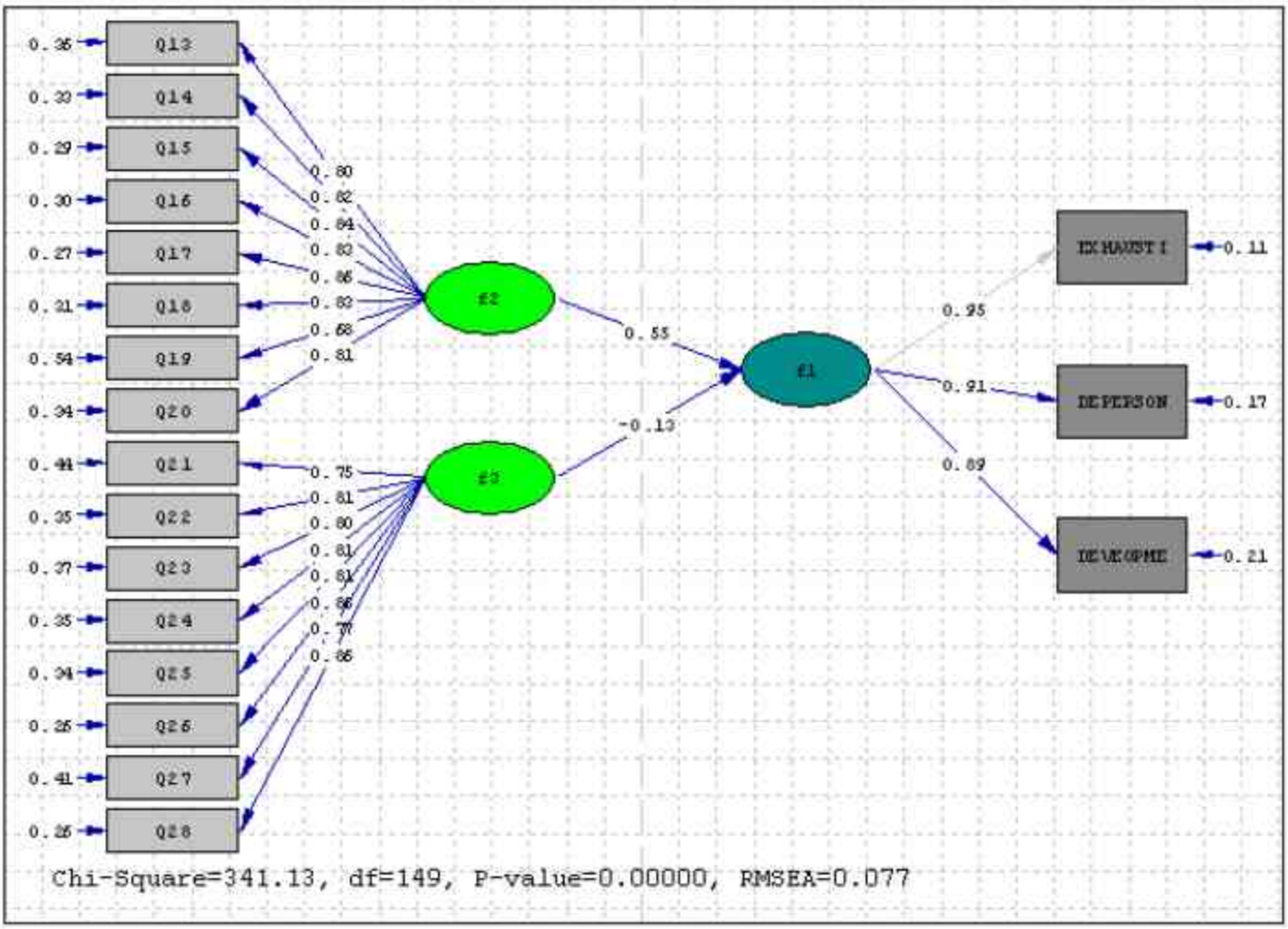


Fig. 2: The Basic Model of Testing the Impacts of Personality Traits, viz., Extraversion and Introversion on Telecommuters' Burnout f1. Burnout, f2.Extraversion and f3. Introversion

Table 3: Fit Statistics and the Optimal Cut Point

Row	*Fit Statistics and the Optimal Cut Point*	*Figures*
1	Chi-Square (P=0.0)	341.13
2	Degree of Freedom (DF)	149
3	Comparative Fit Index (CFI) CFI 0.95	0.95
4	Goodness of Fit Index (GFI) GFI 0.95	0.86
5	Root Mean Square Error of Approximation (RMSEA) RMSEA ≤ 0.08	0.077

Chi-Square with P-Value 0.0 shows significant relationship among variables. CFI value > 0.95 is acceptable as the Table-3 shows the same. GFI > 0.90 or 0.95 is considered acceptable (Hu & Bentler, 1995) though in Table-3 GFI indicates approximately the same. Thus, figures obtained through SEM shown in Table-3 indicate tested model is a good fit for the present research data.

Additionally, through Regression Analysis, the functional relationship between the variables are achieved (Table-4):

Table 4: Regression Analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.716	1.346		4.247	.000
	extroverted	1.974	.253	.523	7.803	.000
	introverted	-.480	.261	-.124	-1.842	.067

a. Dependent Variable: burnout

From Table-4 it can be interpreted if extraversion score increases by 1, burnout unaverage increases by 1.97 and if introversion score increases by 1, burnout unaverage decreases by 0.48 indicating extraversion has positive relationship with burnout (increasing extraversion leads to increasing burnout or vice versa) meanwhile introversion has inverse relationship with burnout (increasing introversion leads to decreasing burnout or vice versa).

6. Discussion

The present study is an attempt to indicate the relationship between personality styles; extraversion and introversion, and burnout. In the light of the above results in Table-3, the goodness of the studied model is proved as seen in fit statistics obtained through testing primary model in SEM. As shown in the findings, it can be construed both predictor variables; extroverted and introverted personality have significant relationship with the criterion variable; burnout. Table-2 connotes the correlation between extraversion and burnout is a direct one thereby an increase in extroverted personality follows by an increase in telecommuting burnout. Whereas, introversion has an inverse correlation with variables extroversion and burnout which means an increase in introverted personality occurs with a decrease in extroverted personality and burnout. . It is seen from Table-1 Chi-Square values indicate there is a significant relationship among variables (it can be obtained online through Chi-Square Distribution Calculator and Chi-Square Critical Values Table as well). So according to later data as well, it can be presumed extraversion has positive relationship with burnout, introversion has negative relationship with burnout and moreover extraversion and introversion have negative relationship with each other Additionally, it is obvious from diagram-2 there is a positive statistical significance of 0.55 between extraversion and burnout while negative one of -0.13 between introversion and burnout. On the other hand, as it is offered in Table-2, figures imply extroverted and introverted personalities have a remarkable inverse relationship to each other. Definitely, any extroverted individual cannot have introverted personality as well. Similarly, in Regression Analysis (Table-4) the nature of the relationship between variables is established and the strength of the model is represented as well. An increase in employee's extroversion personality will increase telecommuting burnout by 1.97 and an increase in introversion personality will decrease telecommuting burnout by 0.48. Through all these interpretations it can be concluded that teleworkers with extroverted personality are more apt to take burnout symptoms during telecommuting job whereas introverted teleworkers show less potential to take telecommuting burnout symptoms. It seems extroverted traits in employees do not suit with telecommuting features although findings show vice versa in introverted employees.

The significance of these findings is that with the help of the obtained results, organizations have this option to match employees' personality to their remote job to prevent or decrease job burnout especially in this constant changing era where IT developments may cause some obstacles for organizations as well.

On the other hand, since the objective of this work is studying of the relationship of extraversion and introversion with telecommuting burnout, the scope of studied theoretical model is limited to only the effects of two traits of personality, viz., extraversion and introversion on telecommuting burnout. Then, the results cannot be associated with other personality styles. Furthermore, other internal and external factors impressing individual's burnout are neglected in this research. In virtue of limited variances in this study, it seems highly improbable to expand these results to other factors and variables. Additionally, since the parameters in this study were limited to those mentioned variables and it was dealt with only the effects of teleworkers' personality on their job burnout and since in the informal discussion, employees mentioned some other factors as pros and cons of dealing with telecommuting; employees' introversion trait might not show its positive relationship with their job burnout.

7. Conclusion

Generally, as respects above discussion, it would be concluded in the studied model which is on the basis of French's model of person-environment fit; individual's personality can have a significant effect on her/his wellbeing in job environment. Actually, personality traits, extraversion and introversion which are studied in this research can determine individual's burnout in remote job setting. With respect to French's model it can be said features of extroverted personality misfits with features of remote work environment, therefore it brings about telecommuter's burnout. On the other hand, features in introverted personality matches with features in this kind of job setting, hence mitigates employees' burnout caused through telecommuting features. Despite of these conclusions, it cannot be said the results are absolutely emerged because of personality types since the teleworkers were not in absolute teleworking job setting so the results can be affected by environmental impacts teleworkers were facing.

References

Amichai-Hamburger, Y., & Ben-Artzi, E. 2000. The relationship between extraversion and neuroticism and the different uses of the Internet. *Computers in Human Behavior, 16*(4), 441-449.

Amiel, T., & Sargent, S. L. (2004). Individual differences in Internet usage motives. *Computers in Human Behavior, 20*(6), 711-726.

Bargh, J. A., & McKenna, K. Y. A. (2004). The Internet and social life. *Annu. Rev. Psychol. 55*(1), 573-590.

Blau, I., & Barak, A. (2012). How do personality, Synchronous media, and discussion topic affect participation? *Educational Technology & Society, 15*(2), 12-24.

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing MI. *Structural Equation Modeling, 9*, 235-55

Ellison, N. B. (1999). Social impacts: New perspectives on telework. *Social Science Computer Review, 17*(3), 338-356.

Eysenck, H. J., & Eysenck, S. B. G. (1975). *Manual: Eysenck personality inventory*. San Diego, CA: Educational and Industrial Testing Service.

Eysenck, S. B. G., Eysenck, H. J., & Barrett, P. (1985). A revised version of the psychoticism scale. *Personality and Individual Differences, 6*(1), 21-29.

French, J. R. P., Jr. (1973). Person-role fit. *Occupational Mental Health, 3*(1), 15-20.

George, J. M. (1992). The role of personality in organizational life: Issues and evidence. *Journal of Management, 18*(2), 185-213.

Hannay, M. (2016). Telecommuting: using personality to select candidates for alternative work arrangements. *Journal of Management and Marketing Research, 20,* 1-12.

Hartig, T., Kylin, C., & Johansson, G. (2007). The telework tradeoff: Stress mitigation vs. constrained restoration. *Applied Psychology: An International Review, 56*(2), 231-253.

Herschel, R. T., & Andrews, P. H. (1997). Ethical implications of technological advances on business communications. *Journal of Business Communications, 34,* 160-170.

Hu, L. T., & Bentler, P. M. (1995). Evaluating model fit. In R.H. Hoyle (Ed.), *Structural equation modeling: Concepts, Issues, and Applications* (pp. 76-99). Thousand Oaks, CA: Sage.

Ivacovides, A., Fountoulakis, K. N., Kaprinis, St., & Kaprinis, G. (2003). The relationship between job stress, burnout and clinical depression. *Journal of Affective Disorders, 75*(3), 209-221.

Jung, C. G. (1971). *Psychological types*. Princeton, NJ: Princeton University Press. ISBN 0-691-01813-8.

Lewin, K. (1951). *Field theory in social science: Selected theoretical papers*. D. Cartwright (Ed.). New York: Harper & Row.

Martino, V. D., & Wirth, L. (1990). Telework: A new way of working and living. *International Labour Review, 129*(5), 529-554.

Maslach, C., & Jackson, S.E. 1981. The measurement of experienced burnout. *Journal of Occupational Behaviour, 2*(2), 99-113.

Maslach, C., Schaufeli, W. B., & Leiter, M. P. (2001). Job burnout. *Annu. Rev. Psychol, 52,* 397-422.

McKenna, K. Y. A., Green, A. S., & Gleason, M. J. (2002). Relationship formation on the Internet: What's the big attraction? *Journal of Social Issues, 58*(1), 9-32.

Moss, M., & Carey, J. (1994). Telecommuting for individual and organizations. Annual Review of Communications. *International Engineering Consortium, 47,* 324-329.

Nilles, J. M., Carlson, F. R., Jr., Gray, P., & Hanneman, G. J. (1976). *The telecommunications-transportation trade off: Options for tomorrow*. New York: Wiley.

Novaco, R. W., & Gonzalez, O. (2009). Commuting and well-being. In Y. Amichai-Hamburger (Ed.), *Technology and well-being* (pp. 174-205). Cambridge University Press.

Peters, P., Tijdens, K., & Wetzels, C. (2001). Factors in employees' telecommuting opportunities, preferences and practices. Research Paper #8, Department of sociology/ICS, Utrecht University.

Useem, J., & Harington, A. (2000). Welcome to the new company town. *Fortune, 62*(74), 8-25.

Van den Broeck, A., Vansteenkiste, M., De Witte, H., & Lens, W. 2008. Explaining the relationships between job characteristics, burnout and engagement: The role of basic psychological need satisfaction. *Work and Stress, 22*(3), 277-294.

Whitehead, M. (1999). Churning questions (call centres). *People Management, 5*(19), 46-48.

Wilson, D. J., & Doolabh, A. (1992). Reliability, factorial validity and equivalence of several forms of the Eysenck personality inventory/questionnaire in Zimbabwe. *Personality and Individual Differences, 13*(6), 637-643.

Article can be accessed online at http://www.publishingindia.com

Business Transformation- Consulting Perspective

Niladri Dutta*, Saumya Choudhury, Swarnabha Shankar Ray****

**Customer Principal, Ericsson RMEA. Email: niladri.dutta@ericsson.com*

***Senior Consultant Ericsson India Consulting, India. Email: saumya.choudhury@ericsson.com*

****Lead Consultant Ericsson, India Consulting, India. Email: swarnabha.shankar.ray@ericsson.com*

ABSTRACT

The current generation of mobile networks continues to transform the way people communicate and access information. Further developing and implementing technologies that enable true human-centric and connected machine-centric networks will come to redefine end user mobility along with the entire landscape of the global telecoms industry. 3G and 4G technologies have mainly focused on mobile broadband use cases, providing enhanced system capacity and offering higher data rates. Future wireless networks should offer wireless access to anyone and anything.

Keywords: Business Process Reengineering, Business Transformation, Digital Transformation, Strategy Formulation, Target Operating Model (TOM), Next Generation Operating Model (NGOM), Business Case, Digitalization, Telecommunication Operations etc.

Fig. 1: Upcoming Technologies

Business and IT stakeholders to establish the value addition and subsequently talks about the approach and methodology that the company followed for its consultative engagement for business and technology transformation for a telecom service operator. We started this journey by creating a business case for justifying a particular function within the business organization and laying the foundation of going for IT transformation in general. The Operational Transformation Strategy has been depicted by the Operating model which acts as the baseline, deriving the process architecture to form an integral part of the enterprise architecture library. To aid the operators ride the change, embrace the digital future; a standard consultative approach is required to understand the strategic vision of the organization and chalk out a roadmap to make digital transformation a possibility. Once the high-level view is blueprinted, the approach talks about going into the details of the existing processes for business transformation

1. BUSINESS CASE OVERVIEW

The world is trying to become completely wireless, demanding uninterrupted access to information anytime and anywhere with better quality, high speed, increased bandwidth and reduction in cost.

A transformation journey is never complete without a set of highly flexible and scalable target business processes defined to cater the business needs, changes happening in the business scenarios, filling up the dots behind to ascertain technological changes necessary to manage the business needs.

1.1 Operator Overview

The operator has made several acquisitions in different countries and especially in Africa in 2005. As the market

in almost saturated in the Middle East, it is moving to International locations and right now has its operation in 17 different countries across Asia, the Sub-Saharan Africa. It is the largest carrier of the international voice traffic in middle-east and Africa and one of the top voice carriers in the world.

With the new acquisition and also with the advent of newer technologies introduced to the market the operator was facing the problem with their legacy systems. The business is becoming critical and it was difficult for them to cope with the business needs and the fast paced business scenarios which are coming up. They don't have the proper IT backbone to support their newer products which they want to launch to counter their competitors. Also the legacy systems are mostly disparate, very little integration amongst them which makes the marketing departments' job very hard when they want to launch any newer technology product with much faster TTM. Most of the time it ends with blame gaming between departments and it lost the first mover advantage so as the opportunity cost.

Fig. 2: Global Presence

Above all, a lot of manual activities makes it even harder and make it error prone. Top management understands that they really need some kind of transformation in order to be at the leader position.

1.2 Business Case Snapshot

Ericsson being a Consulting lead SI organization has engaged with several operators in the past for delivery of large scale transformation projects. One such example is mentioned as an interesting example in the context of this paper. This was primarily with the COO of the organization of the service provider to establish the credibility of business analysis function within the client organization along with other competitors.

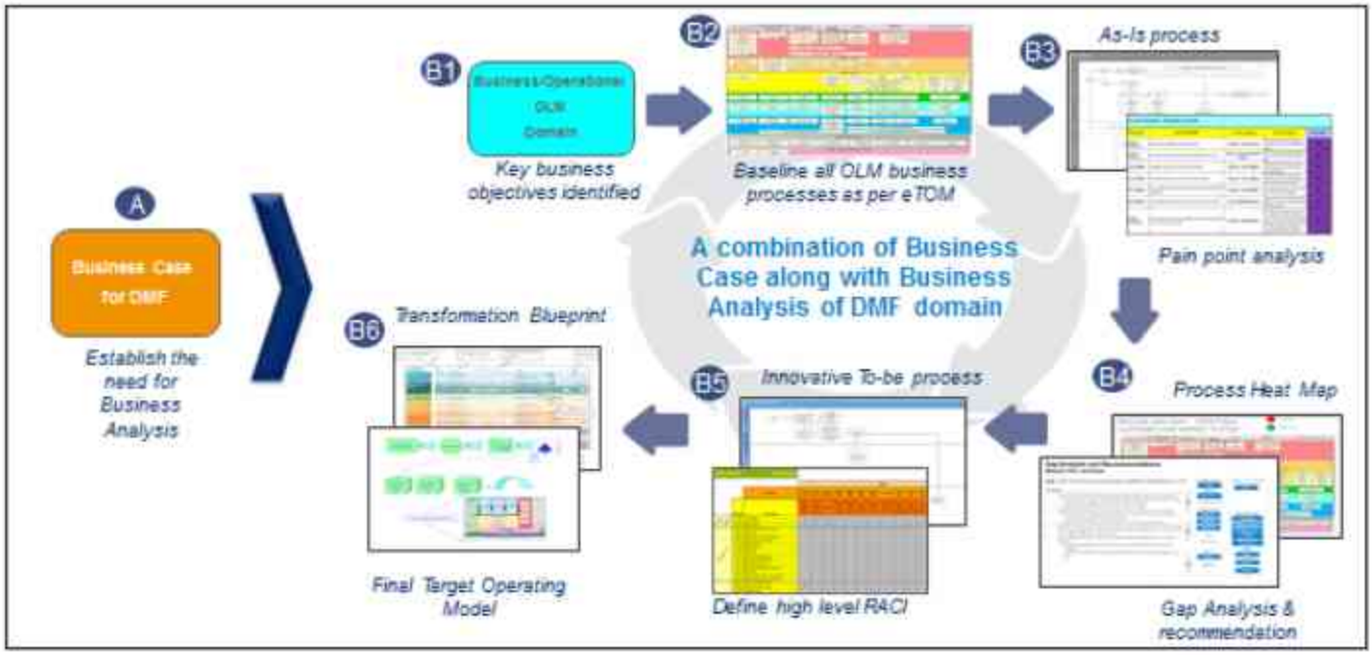


Fig. 3: Consulting Approach - Summary

To establish the credibility of the Demand Management Function (DMF) which would establish business analysis as its core responsibility from a business side. The exercise was kicked off with a consulting led business case around the operator's Order Management domain to demonstrate the value of DMF as a function. The business case would help in establishing the fact that, for a business transformation, a business analysis function needs to be set up. Once the business case is established that, the organization needs to invest in a business analysis function; then Ericsson would go forward with the business transformation. Thus Ericsson would set up the function as well as help the operator with the transformation.

Thus it was a 2 phased approach. Firstly, to establish the credibility with the business organization in creating a business case for the Demand Management functions. Secondly, once the credibility was established we went ahead with the transformation program in general.

The following activities are performed:

1. Analyzed the entire Order Management lifecycle.
2. Collation and compilation of all the Order Management domain pain points addressing the key issues.
3. All initiatives identified by operator's business have been mapped back to pain points and root causes which were further analyzed to complete the e2e impact analysis for Order Management domain.
4. Impact Analysis has been done for the Order Management life cycle to show impact correlation and mapping it across the three domains - Revenue Margin, Customer Experience and Operations Function.
5. Impact analysis further leads to analysis of potential business opportunity loss for the operator.
6. Proposed Solution Identification and proposition for creation of Business Analysis and Requirements Management function across BUSINESS and IT organization of the Operator.
7. Process Governance Model proposed for B2B in the Order Management domain.
8. Business Process design for Incident Management both proactive and reactive scenarios.
9. In addition to the Order Management scope, all low-level requirements analyzed further for the To-be initiatives for CRM domain and mapped it across the solution being implemented.

2. Business Case - Input Analysis

Table 1: Input Analysis

Parameters	*Value in Unit*
Total Orders generated per YEAR	128000
Total Orders generated in effectiveness (80% of the total orders except the orders which are simply manipulated with minor edits)	102400
No# of orders being processed successfully in a YEAR - Voice	90400
No# of orders being processed successfully in a YEAR - Non Voice	12000
No# of orders being processed for Managed Services (Non Voice)	1200
Total turnaround time (TAT) – average per order Voice (80% weight)	4 days
Total turnaround time – average per order Non Voice(19% weight)	10 days
Total turnaround time – average per order Managed Service (Non Voice)(1% weight)	78 days
Weighted average TAT (Voice + Non-Voice+ Managed Service (Non Voice))	4.61 days
Total TAT	5 days
Order Placement and QA	1.25 days
Order Capture and Validation	1.25 days
Order Processing	1.25 days
Process and Governance	1.25 days
Root Cause for delay in TAT	
Business Analysis + Lack of process standardization	0.43
Business Analysis and low level design impact	0.35
Net Impact of Business Analysis and Low Level Design	0.39

**Source – Ericsson Primary Research

The Corporate dimension Impact Analysis (%age wise) done on People, Process and Technology and the following result obtain:

Table 2: Dimension Impact Analysis

Order Management Life Cycle	*People*	*Process*	*Technology*
Order Placement and QA	28.57	100.00	57.14
Order Capture and Preparation	28.57	71.43	57.14
Order Processing	33.33	66.77	44.44
Process and Governance	20.00	100.00	20.00

**Source – Ericsson Primary Research

There are possibilities of one to many relationships like if one single activity can be taken by all people, process and technology or by any combination of those.

Transformation Dimension Impact Analysis calculates the effect of the overall transformation program on the high level KPIs. In this case, we have calculated the percentage improvement that we are expecting as a result of the transformation program (%age problem mitigation).

The Transformation Dimension Impact Analysis (%age wise) also done on Revenue & Margins, Customer Experience and Operational Efficiency. The following table shows the percentage of pain points/requirements that impact RM, CE, OE. After transformation once the pain points are mitigated, an overall improvement in the domains are also expected.

Table 3: Transformation Dimension Impact Analysis

Order Management Life Cycle	*Revenue & Margins*	*Customer Experience*	*Operational Efficiency*
Order Placement and QA	17.86	14.29	25.00
Order Capture and Preparation	7.14	10.71	25.00
Order Processing	3.57	7.14	28.57
Process and Governance	0.00	3.57	17.86

**Source – Ericsson Primary Research

We analyzed the scenarios in details and came up with three different business cases

2.1 Business Case 1

Table 4: Business Case 1

Business Case 1 :		
Effective Target Improvement		***Comments***
Proposal QA	0.7625	[1- 0.39 (tab-1, NET IMPACT)] * Input Proposal QA
Order Capture and validation	0.7625	[1- 0.39 (tab-1, NET IMPACT)] * Input Order capture
Order processing	0.7625	[1- 0.39 (tab-1, NET IMPACT)] * Input Order capture
Process and Governance	0.7625	[1- 0.39 (tab-1, NET IMPACT)] * Input P&G
Total TAT Revised	3.05	Sum of above 4 rows
# of revised orders which are being handled now	167868.85	(Total Orders generated per year/Total TAT Revised)*Total TAT
Average revenue per order - Voice	1735.34	Given
Average revenue per order - Non Voice	2711.20	Given
Average revenue per order - Non Voice Managed Services	14780.47	Given
Average NET Revenue (Voice+ Non Voice+ Managed Services)	2051.20	weighted average (voice 80%, non-voice 19%, non-voice MS 1%
For 1 transformation project only in the Order Handling domain	$134,558,759.60	(Revised order – Total Order)*Avg Net Revenue
For as many as 10 transformation project across OSS/BSS	$1,345,587,596.01	

**Source – Ericsson Primary Research

According to us, the business scenario has its own merits. The inferences drawn from the scenario are the following:

2.1.1 Inferences from Business Case: Scenario 1

- Business Analysis both from Business and IT sides along with lack of process standardization has an effective mean impact of 39% in improving TAT for all category of orders
- Each dimension "PROCESS" would impact the Business Side of Operator and "TECHNOLOGY" would impact the IT side of Operator.
- Revised TAT for all orders for the full life cycle is down to 2.85 days if ONLY "PROCESS" dimension is concerned.
- Revised TAT for all orders for the full life cycle is down to 3.25 days if ONLY "TECHNOLOGY" dimension is concerned.
- Effectiveness in the adaptability of Business Analysis both from Business and IT side will yield "business" benefits.

2.2 Business Case 2

Table 5: Business Case 2

Business Case 2 :		
Voice per day revenue	156874376.6 /year	429792.8126
Data per day revenue	29280909.07/year	80221.66868
Managed Service per day revenue	17736561.63/year	48593.31953
		558607.8008
Per Day Revenue Increment	**Improved TAT of 2 days $yield**	$1,117,215.60

**Source – Ericsson Primary Research

2.2.1 Inferences from Business Case: Scenario 2

- The Average effective revenue gain would be considered for each category – voice, data and managed services.
- The revised TAT will initiate Billing for the customers 2 days earlier hence there would effective gain of 2 days' worth of revenue

2.3 Business Case 3

Table 6: Business Case 3

Business Case 3 :	
# of orders being processed in a year	1200
As per present growth rate and market potential	70%
Revised # of orders being processed in a year	2040
Total Expected Revenue from MS in a Year	$30,152,154.77
TAT Impact %age Improvement	40
Revised TAT for MS Order	46.8
Actual Realized Revenue	$50,253,591.29
TAT Additional Revenue Impact	$20,1010,436.51
	Improved TAT of 2 days $yield

**Source – Ericsson Primary Research

2.3.1 Inferences from Business Case: Scenario 3

- The growth rate of Managed Services product category is 70% YoY (data from Operator business)
- The revised TAT will have an effective gain of 30.15m$ only for Managed Services.

3. Solution Approach

3.1 Business Led Target Operating Model

A good place to start is with a value-chain map. First, identify the focus on product/market segments that the organization is serving. Clarify the offer being given to each segment. Then define, for each segment separately, the value chain of activities that are needed to deliver the offer. Different value chains can then be compared side by side in order to identify steps in the chain that can be "aggregated" to gain economies of scale or "standardized" to gain consistency or "separated" to gain local adaptation. These choices then lead directly to organizational implications. Once these economies of scale achieved can use these to convert to economies of scope.

With that Ericsson presented the problem to Operator which has largely been accepted. The IT system Complexity of Operator leads to low efficiency and low business functionality:

- Slow in responding to business needs.
- Costlier IT Solutions.

- Customer Insights are difficult to get because of complex data structure.
- Not digital enough to offer cloud and other newer services.
- Business processes are not updated and lack of automation.
- Same data is kept in many application so as to make the system very slow and unresponsive.
- Disparate legacy system makes it difficult to scale up.

So a proper Business and IT transformation are required for Operator with a Target Operating Model in place. The Operating Model derived needs to be quantitatively and qualitatively mapped to the drivers which would help identify the tangible benefits, both in terms of revenue and cost for the organization.

Ericsson first chooses to create the basics with the TOM and in this journey the first job is to find out the key parameters.

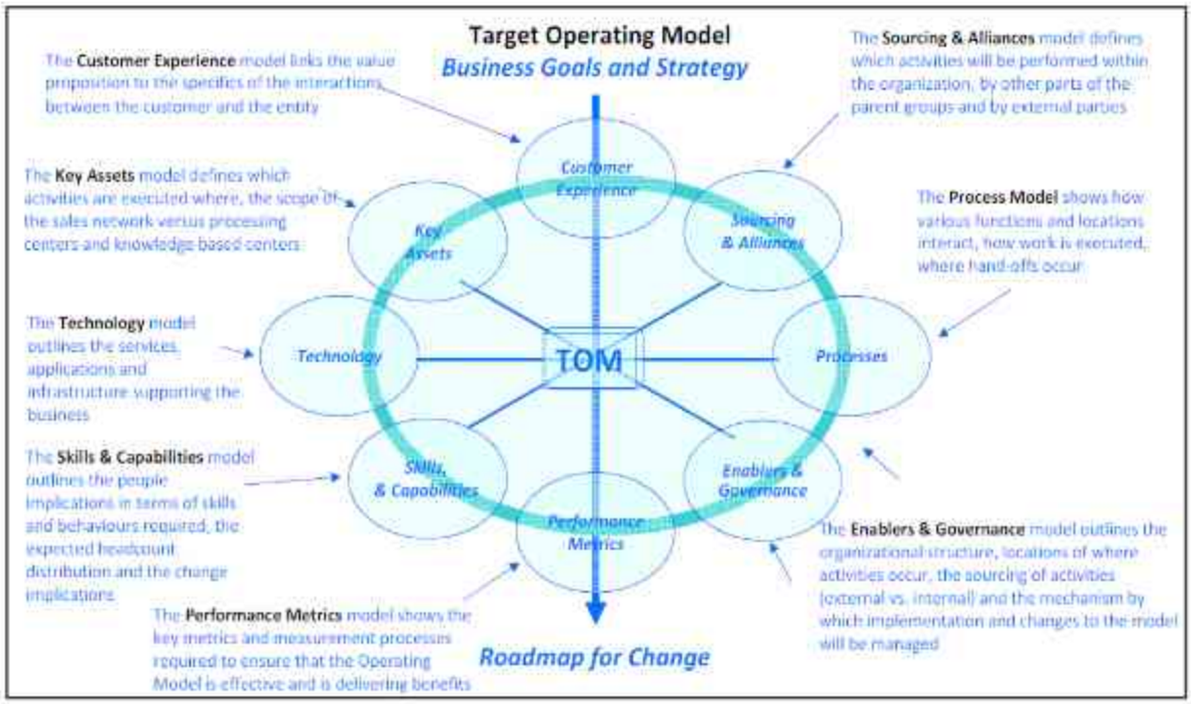


Fig. 4: Target Operating Model

With those key parameter identified for the program, Ericsson started the full transformation journey not only to attain those but also to create a sustainable model for the future.

3.2 Transformation Approach

Ericsson started their journey with their own methodology derived from eTOM which is extremely agile. The following methodology has been adopted that will allow the customer to get their transformation done is a quicker and very minimum distraction from their daily operation:

Two dimensional analyses – one from the organization objective stand point and the other from a business and operational transformation objective stand point

"Corporate dimension" impact analysis done across 3 main dimensions of People, Process and Technology. Each has been broken down into specific parameters for objective analysis

"Business Transformation" impact analysis done across 3 main dimensions of Revenue & Margins, Customer experience and Operational efficiency

Each life cycle stage within the business domain is cross mapped across Organizational impact and Transformational impact to ensure effectiveness and criticality of the overall Business Analysis program

Three-step transformation strategy methodology has been described below:

Fig. 5: Transformation Methodology

3.2.1 Assess & Analyze

During this stage, we will develop an understanding of the current operator landscape including business objectives, processes, organizational structure and capabilities. We will compare that information to industry standard frameworks and reference architectures as well as to Operator's desired target state in future steps.

This will be followed by collecting existing documented processes and conducting maturity assessment and map it to the End to End. We will also assess OPEX and CAPEX efficiency, baseline performance and effectiveness. The process map and performance will later be used in subsequent stages to benchmark against leading industry practices.

Key activities to be executed in this stage include:

- Conduct business stakeholders interviews & work-shops and capture key business requirements.
- Collect & review existing documentation to identify and standardize current state information, current business processes.
- Collect and review customer pain points across functional units in order to identify potential issues and gaps against best practices.
- Map the processes against industry standards and identify preliminary potential gaps.

Outcomes:

- Current As-Is processes
- Pain-Points Capture

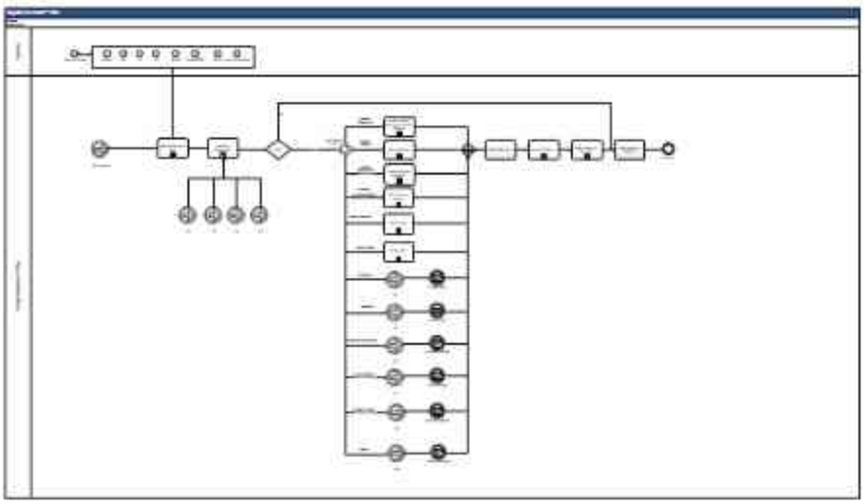


Fig. 6: Current As-Is Processes

S.N	Process Domain	Pain point DESCRIPTION	e Tom Process Mapping	Root cause
68	Service Fulfillment	DPR is over capacity, and Zain is facing ongoing performance issues around the same	Operations - Service Fulfillment	New business Logic Had been implemented inside DPR, which was not considered in solution dimensioning. Impact analysis needs to be performed in order to calculate additional processing requirements - QUR solution had been used for subscription mgmt. as a workaround
71	Service Fulfillment	Provisioning Disconnection Issue, Effecting Customer Experience	Enterprise Risk Mgmt	There's a lack of automation between the service activation and fulfillment set up and TABS leading to poor customer experience management and process gaps with the Zain KSA
73	Service Fulfillment	DPR Leakage in executing processing actions triggered from CRM (Operational Issue)	Enterprise Risk Mgmt	This is an operational issue as raised for the RAPM team in the pain point gathering meeting. Ericsson needs to investigate more.
74	Service Fulfillment	Issue between VAS MSDP pool with [illegible] customer is deactivated, while he can still use [illegible] on VAS)	Enterprise Risk Mgmt	Process/Operational issue that needs to be more investigated by Ericsson.
75	Service Fulfillment	TABS and SDP database [illegible] case conflict regarding customer profile. Due to this phenomenon, provisioning of VAS services would face problem i.e. Customer not being in SDP database, where it exists in TABS database	Operations - Operational Support & Readiness	DPR activation works in a "fire & forget" manner, so even if there's a failure in the activation attempt, DPR doesn't retry and/or back-provision to report to Int. - There's no notification sends back to SDP, on the other hand DPR supports retry mechanism and call back

Fig. 7: Pain-Points Capture First part

	Analysis and Inputs							Output and recommendations						
Root cause	Process	People	Technology	Process Maturity	Training Capability	Operating Efficiency	Priority of Need	Process Impact	Solution Impact	Recommendations prioritization	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			x			Yes	[illegible]		Yes	Medium		Yes		
[illegible]	x		x	Yes	Yes		[illegible]	Yes	Yes	High		Yes		
[illegible]	x		x	Yes	Yes	Yes	[illegible]	Yes	Yes	High		Yes		
[illegible]	x		x	Yes		Yes	[illegible]	Yes	Yes	High		Yes		
[illegible]	x		x		Yes	Yes	[illegible]	Yes	Yes	Medium		Yes		
[illegible]	x					Yes	[illegible]	Yes	Yes	Medium				Yes
[illegible]			x		Yes	Yes	[illegible]		Yes	Medium				Yes
[illegible]		x	x	Yes	Yes		[illegible]	Yes		High		Yes		
[illegible]	x	x	x		Yes	Yes	[illegible]		Yes	High				Yes

Fig. 8: Pain-Points Capture Second part

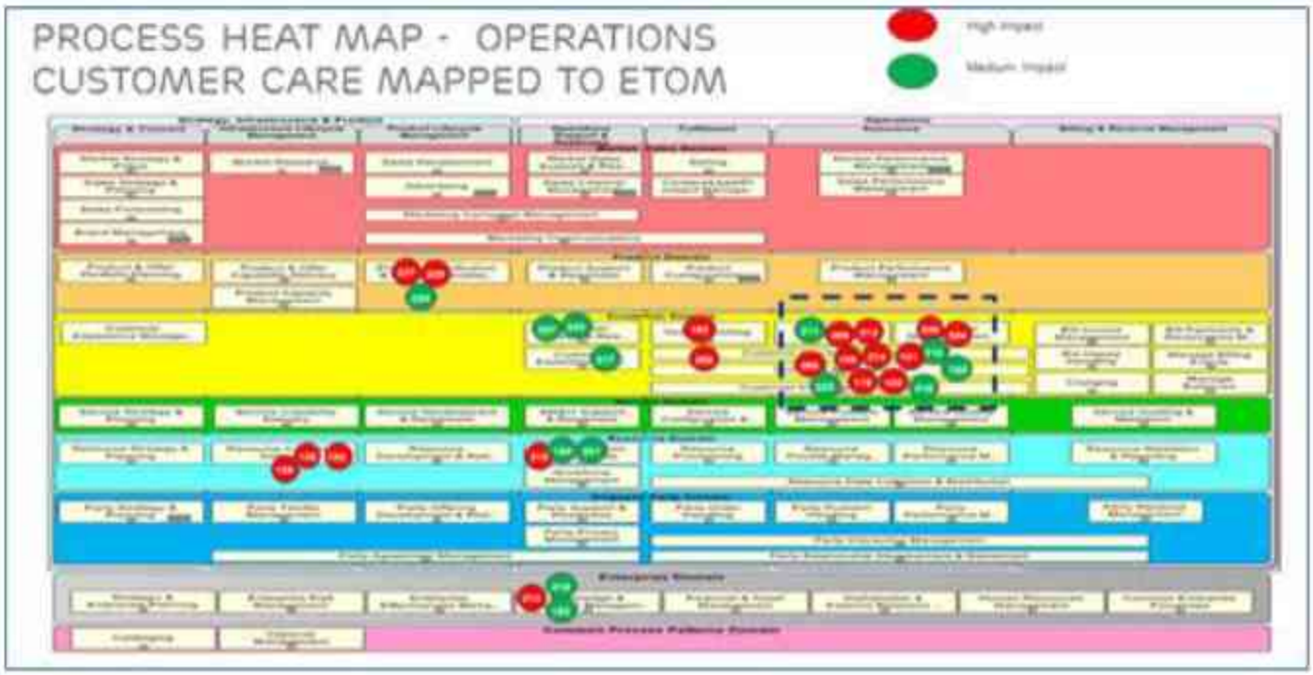


Fig. 9: Pain-Points Capture

During this phase, we will also analyse the information and benchmark against leading industry practices. Key activities to be performed in this stage include:

- Assessment of documented current state of processes.
- Identify gaps & improvements based on Telecom Managed Services best practices.
- Align with the to-be Technical Backbone.
- Design of to be processes to the lowest business process level (one step above the Network/IT backbone) using the Telecom industry best & next practices.
- Cost vs Value comparative analysis of the target stacks.

Outcomes:

- As-Is & To-Be process Gap Analysis.
- Find out the key focus areas/pain points.
- To-be Business Processes to import to Operator process tools.

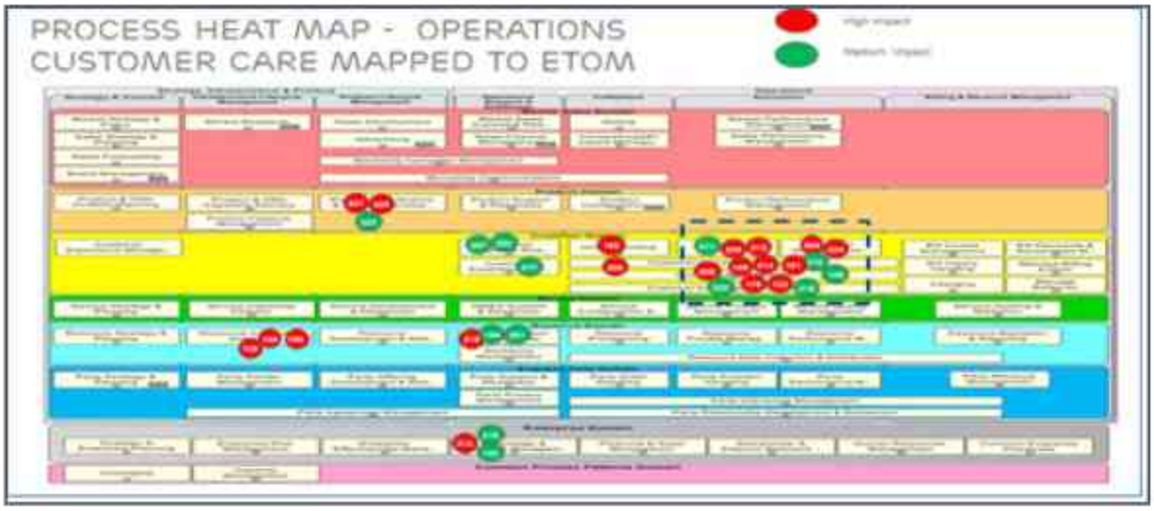


Fig. 10: Process Heat Map

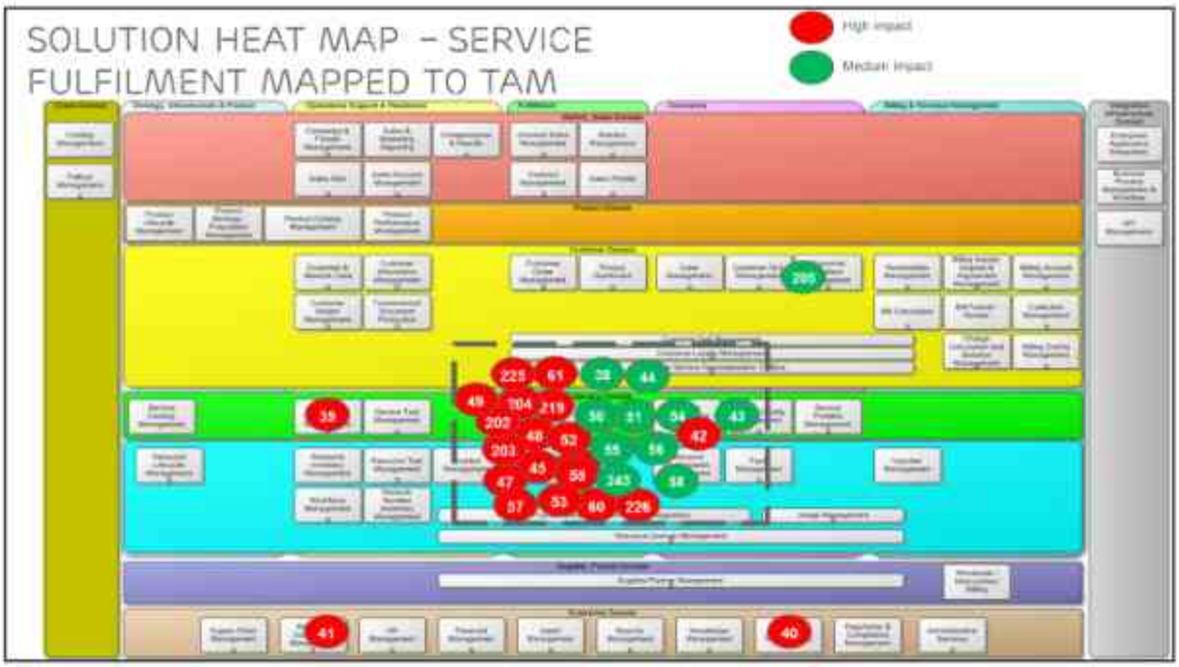
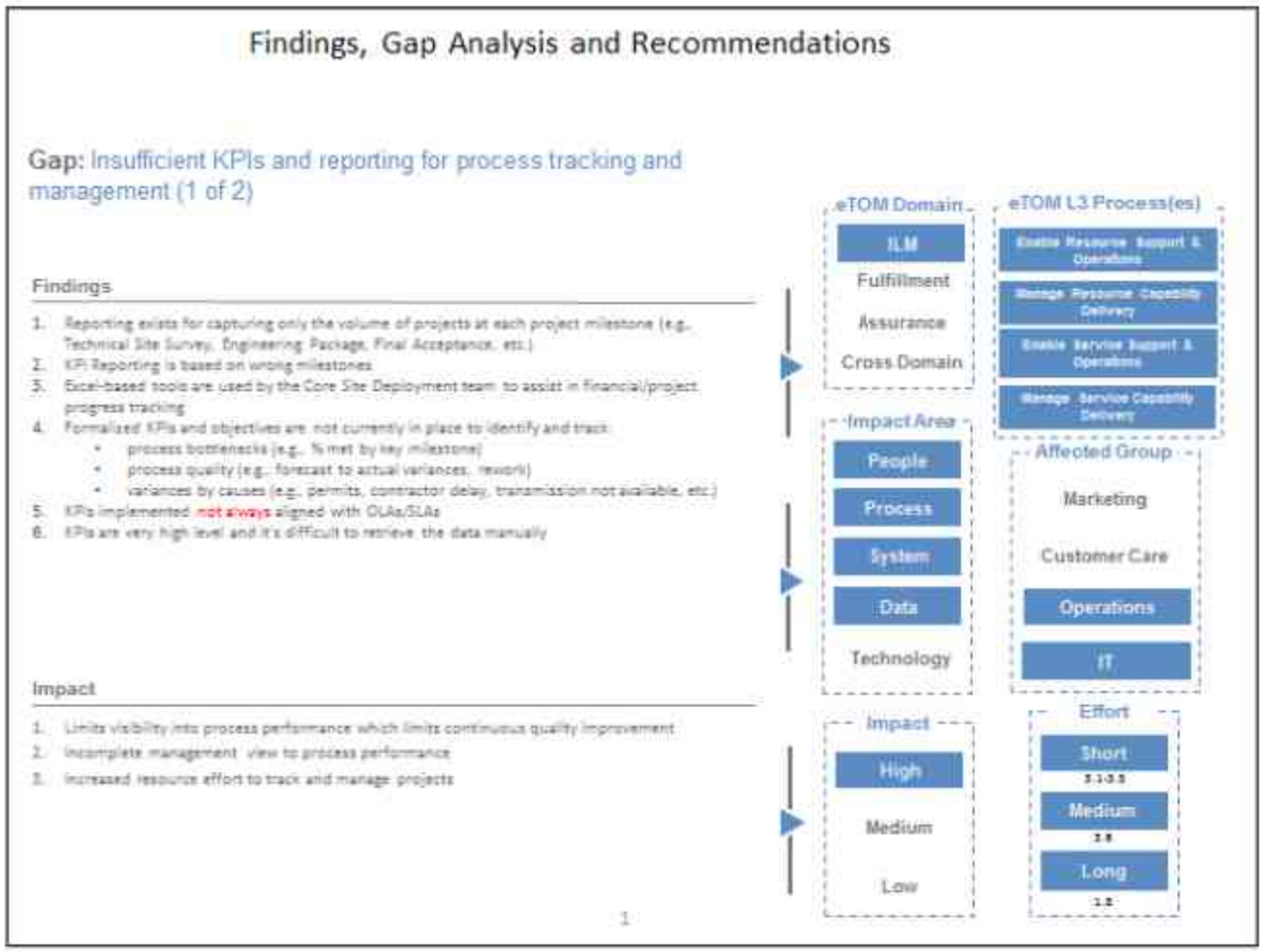


Fig. 11: Heat Map Analysis of the Pain Points



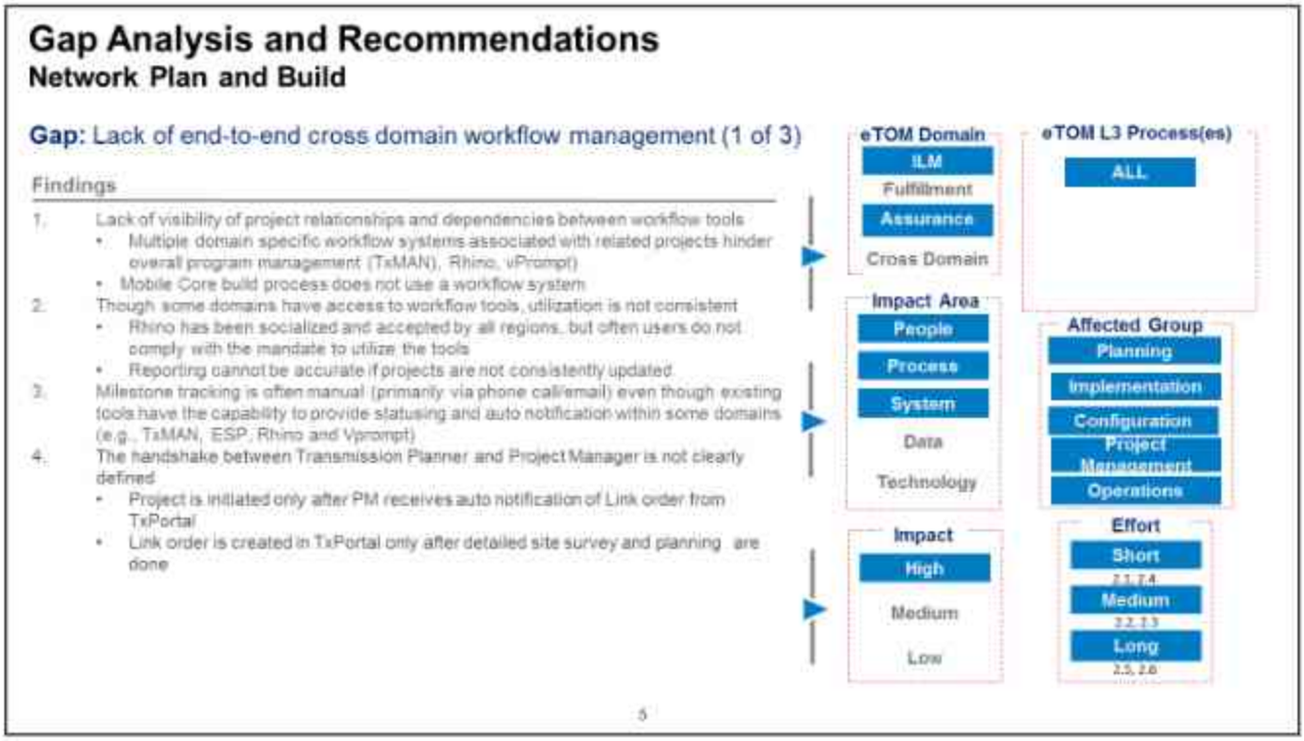


Fig. 12: Gap and Impact Analysis and Recommendations

3.2.2 Innovative To-Be

In this phase, we will focus on identification and alignment of short-term initiatives to long-term goals and the development of feasible options for re-engineering target processes. Staff training and Process trial/test will also be conducted during this stage.

Using feedback received in earlier steps, we will refine the recommendations and create the high-level target operating model that addresses alignment across technology, organization structure and capabilities, guideline processes and KPIs that will be used to measure the success of and progress toward the transformation vision.

Key activities to be performed in this stage include:

- Define Performance Metrics for each process area.
- Recommend and kick-off a roadmap for process automation.
- Perform analysis based on those gaps and pain points, provide recommendations for the strategic roadmap in future steps.
- Propose changes and recommend organization chart.
- Trial/Test Processes whilst providing OJT and class-room training.

Outcomes:

- Recommendations to address gaps in systems, processes and organizational structure.
- RACI Model covering KPI view.
- To-Be processes (aligned to systems architecture and industry good practice) and related dashboards.
- Proposed organization, staffing, roles and related competencies.
- Training and updated processes based on trial/test results.

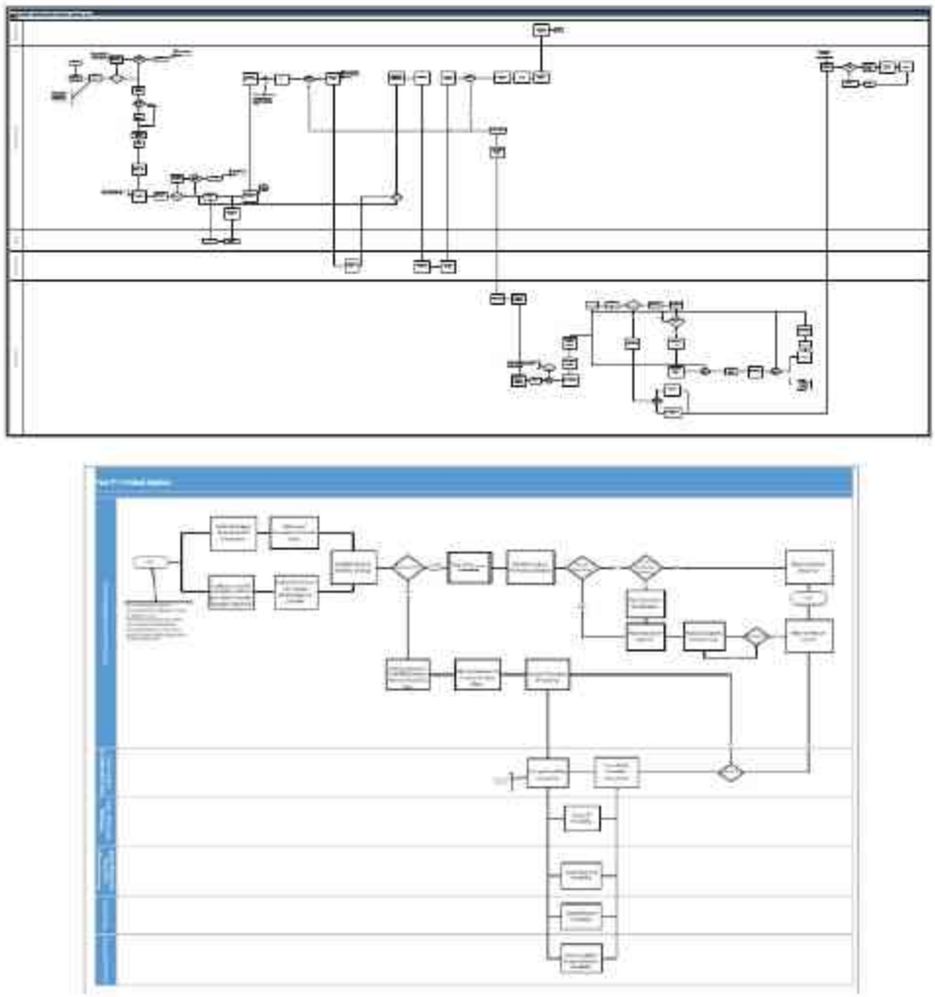


Fig. 13: To-Be Processes

RACI Model												
			Partner Relationship Management									
	Process ID	Process name	KR Agent	RD Agent	MD Agent	KR Admin	RD Admin	MD Admin	RD Agent	Device Distributor Agent	General Warehouse	CT - ERP/MMS User/Support
	PCS-014	New Stock Order - Recharge Cards										
	PCS-015	New Stock Order - Fixed										
Partner Relationship Management	PRM-001	Customer ordering Phone from KR/RD	R	R		A	A					I
	PRM-002	Customer ordering Stock/Device from KR	R			A						I
	PRM-003	Customer ordering mobile prepaid service from Partner	R	R	R	A	A	A				I
	PRM-004	Customer ordering mobile postpaid service from KR	R			A						I
	PRM-005	Customer Enquiry	R	R	R	A	A	A				
	PRM-006	Customer Complaint via Partner	R	R						R	R	
	PRM-007	KR Campaign Sale	A									
	PRM-008	KR Reseller with Sale	R						R			
	PRM-009	Partner Registration				A	A		R			
	PRM-010	Partner User Administration										I
	PRM-011	KR/RD Requisition Order				R	R					I
	PRM-012	KR/RD Order Fulfilment				R	R					I
	PRM-013	KR/RD Penalties				R	R					
	PRM-014	Partner Enquiry	R	R		A	A					
	PRM-015	Partner Complaint	R	R						R	R	
	FIN-039	EPM										
	FIN-040	SAME - Online Payments Processing & Reconciliation										
	FIN-041	Mobile Pay transaction processing & reconciliation										
	FIN-042	Returned Cheque										
	FIN-043	Payment Compliance										

Fig. 14: RACI Model

Service Fulfilment				
Process Transformation Enabling Capabilites	**Identified High Level Specific Capabilities**	**Drill down capabilities**	**Business Benefits for the Customer**	**HIGH LEVEL Performance Metrics**
Improve Customer Order Feasibility	Check the availability and/or the feasibility of providing and supporting standard and customized product /service offerings where specified to the customer	Determine Customer Order feasibility to check the availability and/or the feasibility of providing and supporting customer specific products & services. Determine the availability and supportability of product offering to customer. Determine whether the offering can be supported by other CRM processes.	Supreme Customer Experience & Increased Operational Efficiency	% increase in Customer Satisfaction Index
Improve quality of customer credit authorisation	Assess a customers credit worthiness in support of managing customer risk and company exposure to bad debt	Initiate customer credit check and for authorizing credit and credit terms in accordance with established enterprise risk and policy guidelines. Payment processing from PoS to back office Finance , and all data points pertaining to a single transaction should be seamless without any lags or delays , also it has to be accurate in terms of both 'count' and 'volume' of the data. Defined processes for Customers liable to pay and have not paid , mapped to the customer profile of a customer , appropriate risk mitigation steps to be taken to ensure revenue is recovered and customer should not be harassed if it's a genuine customer , and appropriate measures taken in case of a Black list customer.	Revenue Enhancement	% reduction in revenue leakages

Fig. 15: Performance Metrics

3.2.3 Iterative Finalization

Based on the target operating model, Strategic Goals, Gap Assessment, and Recommendations, we will develop a strategic roadmap that describes the path forward for Operator's Governance and Service Management Framework Implementation.

We will identify executive decision points over the time frame covered by the roadmap to ensure that there are logical checkpoints defined throughout the transformation program at which senior stakeholders will need to make decisions to continue moving the program forward (i.e. partner selection and internal resource alignment).

Key activities in this phase include:

- Building the Transformation Blueprint for transitioning from As-Is to To-Be states and impact to strategic objectives.

- A poster-sized view of the current work streams related to the transformation initiative showing the relationship between the as-is and to-be states, initiatives, business units and strategic objectives.
- Aligns the program and organizational units to the achievement of business benefits & operator's strategic vision – not to project milestones.
- Cost estimates for Governance & SM Framework implementation
- Final executive presentation describing the agreed transformation plan.

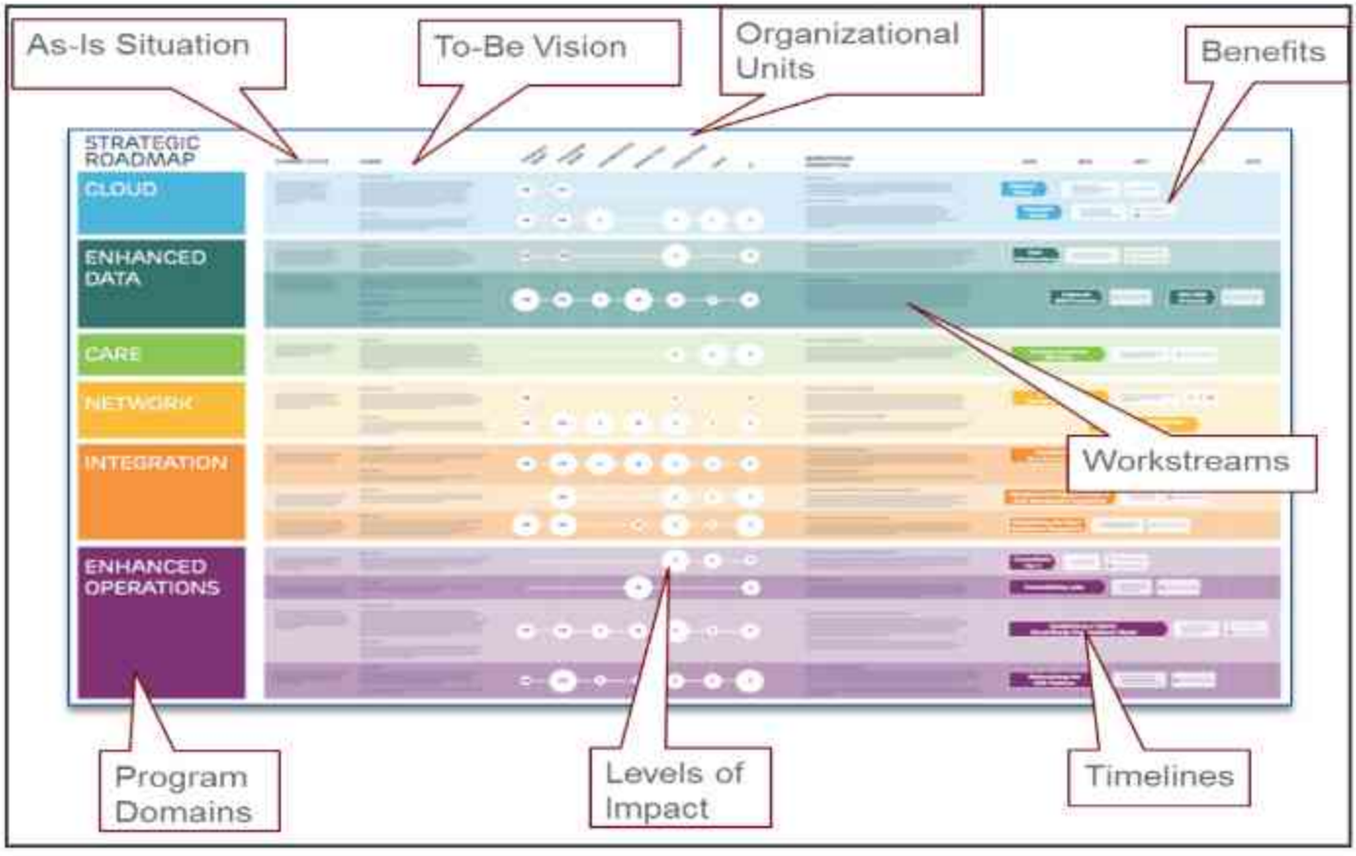


Fig. 16: Operator's Governance and Service Management Framework Implementation

Outcomes:

- Transformation Program Blueprint for Governance and Service Management Framework Implementation.
- Identification of "Low Hanging Fruit" that could help achieve Quick Wins and build traction for the initiative.

3.2.3.1 Deriving the TOM

As the transformation is done now so the derivation of TOM with processes and KPIs defined is much easier as the transformation was based on the TOM parameters only

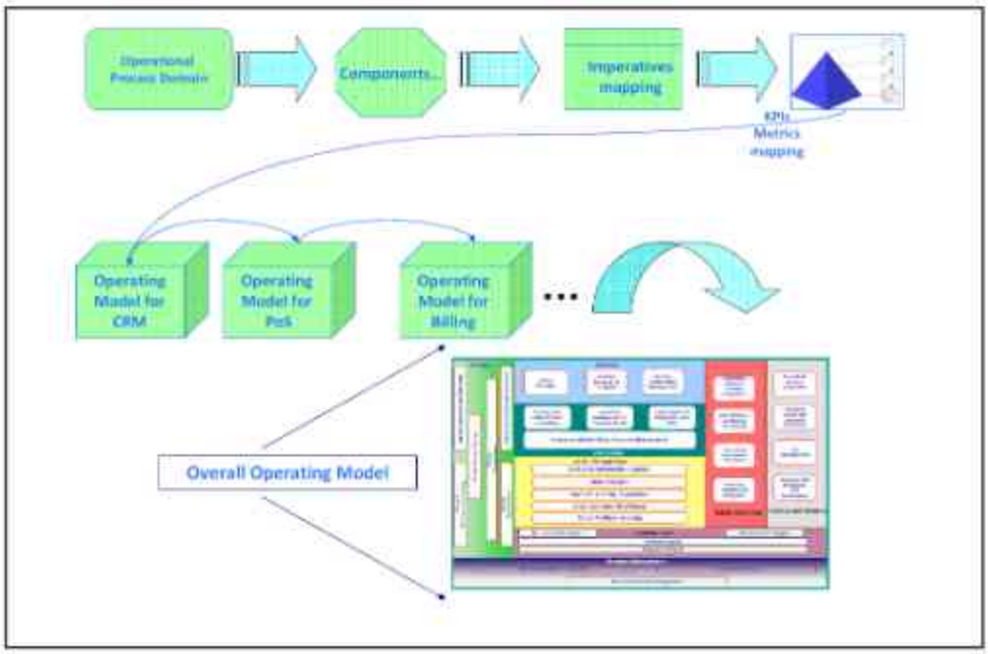


Fig. 17: TOM KPI Metrics and Processes Mapping

Once the TOM is done it helps to provide:

- an operational vision to the IT Strategy team in guiding them through what should be done in an ideal state scenario.
- single view of People, Process and Technology along with organization roles and responsibilities helping operator decide on Operational Strategy for short term and long term.
- gives a unique correlation between business objectives and operational vision.
- flexible model stating possible operational impact zones for Change Management.
- helps align Operational KPI's to the Operational strategy.

Fig. 18: Benefits to the Organization

4. Final Organizational Benefit of The Whole Program

The final outcome of the entire program is the transformation blueprint from the current state to the desired organization state to achieve business goals. It gives a poster-sized view of the current work streams related to the transformation initiative showing the relationship between the as-is and to-be states, initiatives, business units and strategic objectives. The program also helps in the Identification of "Low Hanging Fruit" that could help achieve Quick Wins and build traction for the initiative.

Keeping this blueprint as the reference, the IT, systems and organization transformation would lead to intangible benefits like a more flexible and modern organization with clear defined roles and responsibilities, new age systems to handle the changing need of the customer, department and system wise integration of the organization. Tangible benefits would be the improvement in customer experience, faster TTM for new product launch/update or decommission, reduction in operations time and manual effort, faster training of new employees due to set processes and proper documentation, elimination in unnecessary legacy applications and improvement in service fulfillment time.

GLOSSARY

XG (2G, 3G) – X Generation

TCO – Total Cost of Ownership

POC – Proof of Concept

TTM – Time to Market

GTM – Go to Market

QA – Quality Assurance

TAT – Turn Around Time

OSS/BSS – Operation Support System/Business Support System

TOM – Target Operating Model

RACI – Responsibility, Accountability, Consult, Inform

XG (2G, 3G) – X Generation

B2B – Business to Business

E2E – End to End

CRM – Customer Relationship Management

QA – Quality Assurance

KPI – Key Performance Indicator

REFERENCES

http://www.insidehousing.co.uk/embracing-digital-change/7004998.article

Ericsson Internal Reports

https://www.researchgate.net/profile/Ayham.../55ae2a1e08ae98e661a51c4c.pdf

Article can be accessed online at http://www.publishingindia.com

Overview of LTE based Cellular V2X Communication

Padma Panchapakesan

Sr. Solution Architect, Tech Mahindra Ltd, India. Email: PP00345770@Techmahindra.com

Abstract

Vehicle-to-Everything Communication (V2X) is a technology that allows a vehicle to communicate with different entities of the traffic system. These entities include other vehicles (V2V), pedestrians (V2P), infrastructure like traffic signals (V2I) and application servers (V2N). V2X applications can transform existing transportation systems into Intelligent Transport Systems (ITS) that will provide intelligent services such as autonomous driving, collision warning, traffic regulation and infotainment.

IEEE 802.11p Wireless Access in Vehicular Environments (WAVE) based radio access has laid the foundation for V2X communication. It defines enhancements to IEEE 802.11 to support ITS applications. IEEE 802.11p allows vehicles to communicate their state, such as position and speed, to surrounding entities. However, though IEEE 802.11p gives acceptable performance in sparse networks, its performance deteriorates drastically in dense and high load conditions. In dense networks, the probability of collision of data packets increases significantly thereby reducing throughput and increasing delays.

Cellular V2X is the use of cellular radio access technologies like LTE for V2X. It has been shown that LTE V2X provides better performance in different network conditions and provides better mobility support than IEEE 802.11p. It is also suitable for most of the use cases of V2X. In this study, we have done systematic literature review of LTE and IEEE 802.11p based V2X. We present a technical overview of LTE V2X and describe a few important use cases. We also present a comparison of LTE V2X with IEEE 802.11p and highlight the benefits of using LTE for V2X.

Keywords: V2X, LTE, IEEE 802.11p, ITS

1. Introduction

Vehicle-to-Everything (V2X) is a communication system that allows a vehicle to interact with all other entities of the traffic system around it. These entities can be other vehicles, pedestrians or road side units (RSU) like traffic lights, speed monitors, light poles etc.

The most important goal of V2X is to improve road safety. Studies show that road accidents are one of the leading causes of death across the world. V2X can be used to exchange timely warning messages between traffic entities thereby reducing chances of accidents. Each vehicle can also periodically broadcast certain parameters about it like location, speed, direction etc., which can help other vehicles take safe decisions.

Information exchange between RSUs and vehicles can also be used to monitor, regulate and manage traffic efficiently. An efficient traffic management system will ease congestion and reduce the average time spent by commuters on road. V2X will be a key enabler to redefine existing transport system into Intelligent Transport Systems (ITS) that will provide intelligent services such as autonomous driving and remote diagnostics. It will also open up a plethora of opportunities for service providers to develop and provide various new convenience and commercial applications that will benefit end users.

2. V2X Literature Review

V2X requirements are slightly different from the requirements of existing technologies like Wi-Fi and cellular technologies. Hence it is necessary to either come up with a new technology or enhance existing technologies so that they meet all the V2X requirements. Karagiannis et al. (2011) explain the characteristics of V2X in detail. They also discuss about the requirements and challenges of V2X. WAVE and LTE based Cellular V2X are two most promising technologies for V2X. Jiang & Delgrossi (2008) give details about WAVE which is an IEEE standard for V2X communication. 3GPP TS 36.300 gives an overview of LTE V2X. Service requirements of LTE V2X are described in 3GPP TS 22.185. 3GPP TS 23.285 and R1-15660 describe the enhancements done in LTE to support V2X applications.

3. Objective of the Paper

We have done systematic study of V2X and its technical requirements from existing literature. The purpose of this paper is to summarize the concept of V2X in simple terms. We also give technological insight into IEEE 802.11p based WAVE and LTE V2X and compare their performance under different conditions.

4. Applications of V2X

V2X applications can be classified into three main categories, namely, Road Safety, Traffic Management and Infotainment. Some applications in each category are mentioned below.

4.1 Road Safety

1. Collision Risk Warning: A vehicle that intends to take a sharp turn warns other vehicles and can prevent collision.
2. Overtaking Warning: A vehicle that is overtaking another vehicle sends signals to all other vehicles around it to make overtaking safe.
3. Vulnerable Road User Warning: Pedestrians or RSUs can warn approaching vehicles about the presence of a vulnerable user like a pedestrian or a cyclist.

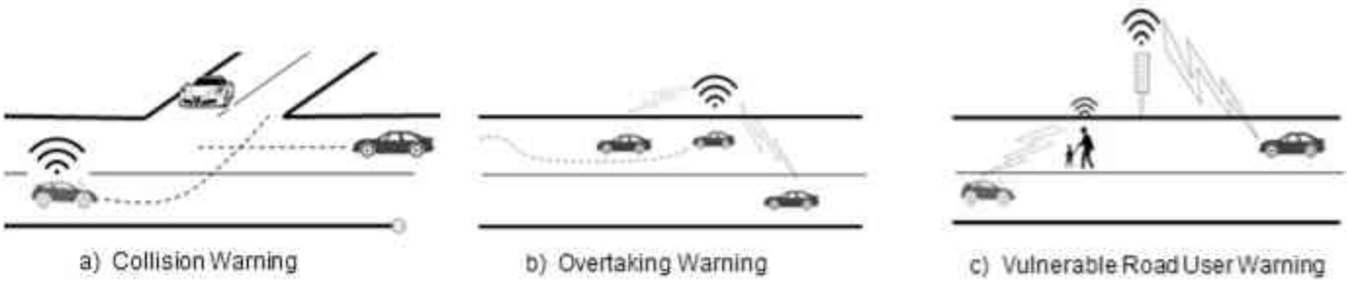


Fig. 1: Road Safety Use Cases

Source: ETSI TR 102 638

4.2 Traffic Management

1. Detour Warning: RSUs can broadcast messages to vehicles warning them about road work and ask them to take a detour.
2. Speed Limits: RSUs can periodically broadcast current local speed limits.
3. Intersection Management: Traffic signals at crossroads can interact with one another to improve traffic efficiency. For example, signal timings can be optimized based on the number of vehicles in each direction.

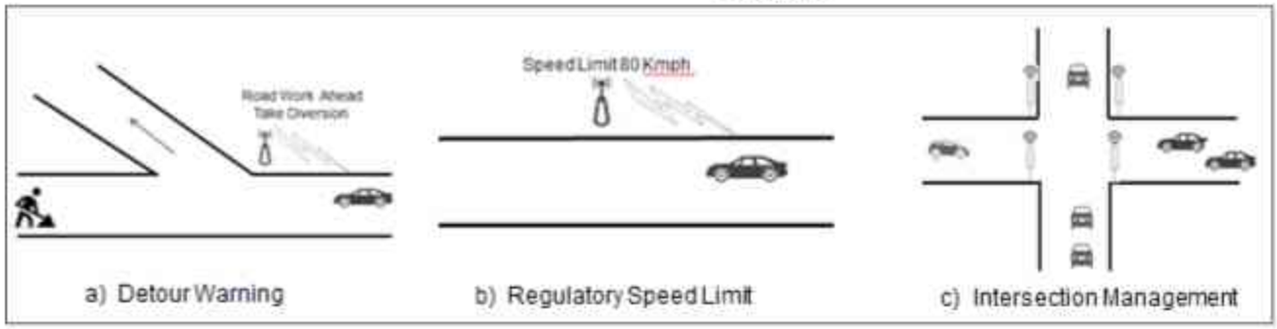


Fig. 2: Traffic Management Use Cases

Source: ETSI TR 102 638

4.3 Infotainment

1. Media Downloading: RSUs connected to internet can provide multimedia for passenger entertainment.
2. Point of Interest Notification: RSUs can inform vehicles about nearby points of interests like restaurants, malls etc.

3. Remote Diagnostics: Vehicles can report their current functional state to a nearby RSU which in turn can send the report to a service center. The service center can remotely provide help in case of any problem.

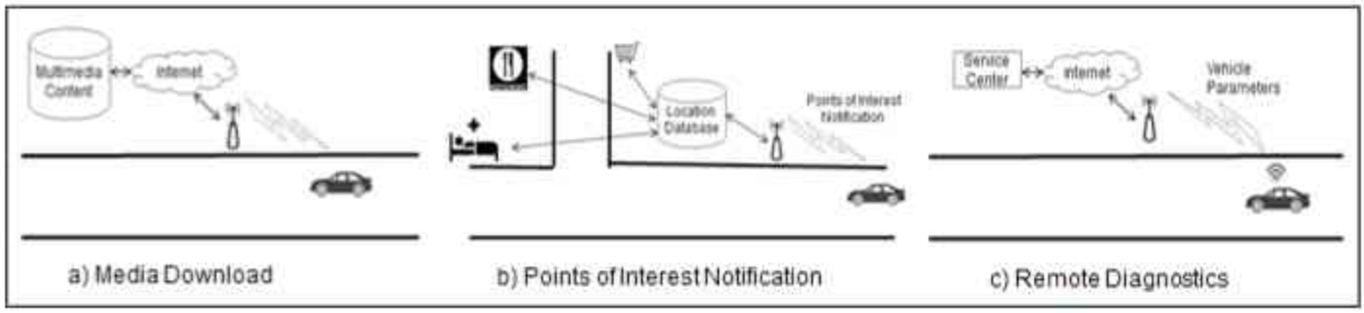


Fig. 3: Infotainment Use Cases

Source: ETSI TR 102 638

5. V2X Modes of Operation

To cater to the different use cases defined in the previous section, vehicular communication needs to operate in the following four modes (Fig. 4)

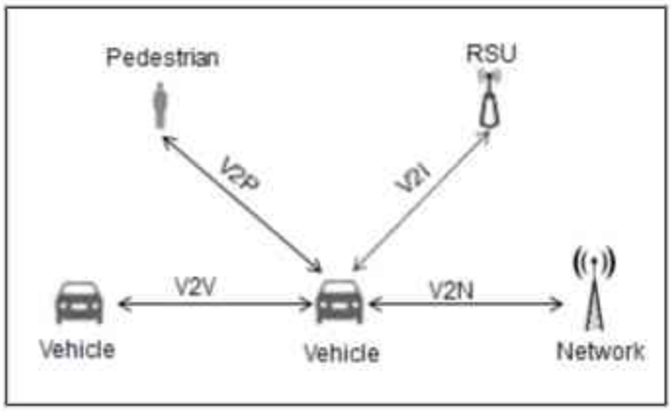


Fig. 4: V2X Modes

Vehicle-to-Vehicle (V2V): V2V is the communication between devices mounted on moving vehicles. Vehicles can exchange information about their current location, speed, direction and certain other parameters. The amount of data exchanged in this mode may not be very high but they do require very low latency. This mode of operation will be mainly used for road safety.

Vehicle-to-Pedestrian (V2P): V2P is the communication between vehicles and pedestrians or cyclists. This mode will also be mainly used for road safety. Throughput and latency requirements of V2P are similar to V2V. The main difference between V2P and V2V is due to the properties of the device. For example, the device used by pedestrians might have lower battery capacity, and therefore it may not be able to send messages with the same periodicity as devices mounted on vehicles. Mobility requirement is also low for these devices.

Vehicle-to-Infrastructure (V2I): V2I is the exchange of information between a vehicle and a RSU. This mode can be used for Traffic management and infotainment.

Vehicle-to-Network (V2N): V2N is the communication between a vehicle and application servers in the network. It can also be used for communication between vehicles that are not within communication range of each other. These applications may require high throughput but latency requirements are not as stringent as V2V or V2P.

6. Requirements of V2X Communication

The underlying technology that is used for V2X communication should meet the following basic requirements.

Interoperability: It should be a standard solution that can guarantee interoperability between different devices.

Range of Operation: Road Safety Applications like Collision warning systems should work at a very short

range of a few meters. However traffic management applications may need longer ranges of 500m – 1000m.

Low Latency: End-to-end latency for critical V2V and V2P applications should be less than 100ms.

Multipath Environment: The technology should work well even in extreme multipath environments without affecting receiver performance.

High Speed: It should work well in all four modes even at high speeds (280 km/hr.)

Spectrum: It should be able to operate in ITS bands allocated by regulatory bodies like FCC and ETSI. For example, FCC has allocated 75 MHz of spectrum in the 5.9 GHz band and ETSI has allocated 30 MHz of spectrum in the 5.9 GHz band for ITS.

To meet the above requirements, IEEE and 3GPP have come up with new standards for V2X communication called WAVE and LTE V2X respectively. In the next few sections we give an overview of both these technologies.

7. WAVE Standard for V2X Communication

Wireless Access in Vehicular Environment (WAVE) uses IEEE 802.11p which is derived from the stable IEEE 802.11a Wi-Fi standard.

IEEE 802.11a is a proven standard and works well in indoor environments. However, V2X communication requirements are different from the regular indoor Wi-Fi requirements. Hence a few modifications are done to make it suitable for vehicular communication. Some important differences between IEEE 802.11a and IEEE 802.11p are tabulated in Table 1.

Table 1: Differences between IEEE 802.11a and IEEE 802.11p

Feature	*IEEE 802.11a*	*IEEE 802.11p*
Band of operation	2.4GHz and 5 GHz	5.9 GHz ITS Band
Channel bandwidth	20MHz	10 MHz
OFDM Symbol Duration	4 µsec	8 µsec
Cyclic Prefix	0.8µsec	1.6µsec
Channel Access	CSMA/CA	EDCA and CSMA/CA

In IEEE 802.11p, OFDM symbol and cyclic prefix durations have been doubled as compared to IEEE 802.11a. Longer OFDM symbol and cyclic prefix durations reduce ISI in multipath propagation environments. Bandwidth reduction from 20MHz to 10MHz also has the effect of reducing RMS delay spread in vehicular environments.

Channel access scheme has also been enhanced in IEEE 802.11p. Both IEEE 802.11a and 802.11p are based on CSMA/CA. In CSMA/CA, users sense the channel to see if it is idle. If the channel is idle, they transmit their packets. If the channel is busy or if they sense any collision, users back-off for a random amount of time and retry. IEEE 802.11p uses Enhanced Distributed Channel Access (EDCA) in addition to CSMA/CA. In EDCA, data packets are assigned different priorities based on their criticality. Higher priority data are assigned shorter back-off time, thereby reducing the latency for time critical applications.

7.1 Key Issues of WAVE

WAVE meets most of the V2X requirements and works well under low traffic loads. However with CSMA/CA, the probability of packet collisions and average latency increase significantly with traffic density. This has an adverse impact on critical time sensitive V2X applications which require extremely low latency.

Secondly, as a result of increasing the symbol duration and guard period to reduce ISI, the OFDM subcarrier spacing in IEEE 802.11p is halved to 0.15625MHz. This makes WAVE susceptible to Doppler Effect causing significant inter-subcarrier interference thereby reducing its reliability at high speeds.

8. LTE Based Cellular V2X

3GPP has also introduced enhancements in LTE to meet V2X requirements. The main enhancements are addition of new nodes in the network architecture, use of sidelink communication for time critical applications, changes in scheduling methods and some changes in frame structure.

8.1 Architecture

LTE V2X network architecture is given in Fig. 7. A few additional nodes and interfaces are added to the LTE network to support V2X.

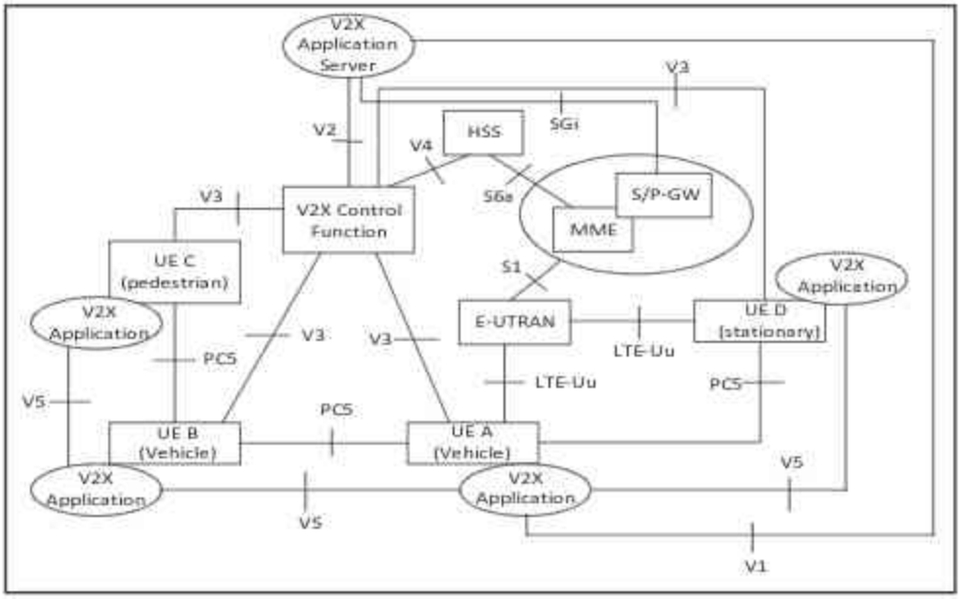


Fig. 5: LTE V2X Network Architecture

Source: 3GPP TS 23.285

The important functional entities with respect to V2X are mentioned below:

- V2X Control Function is a logical node that provisions UEs with necessary parameters for V2X communication. It provisions UEs with PLMN specific parameters that allow them to use V2X in those PLMNs. It also provisions UEs with parameters that are needed when UEs go out of network coverage.
- MME obtains subscription information related to V2X from HSS and provides indication to E-UTRAN about UE's authorization status for V2X.
- V2X Application Server receives unicast uplink data from UEs. They also deliver data to UEs in targeted areas either using unicast or multicast.
- V2X applications run on V2X capable UEs. These UEs can communicate directly using sidelink communication via the new PC5 interface. They can also communicate with E-UTRAN using Uu interface.

8.2 Sidelink Communication

Typically in LTE, devices communicate with each other via the network as shown in Fig. 5.

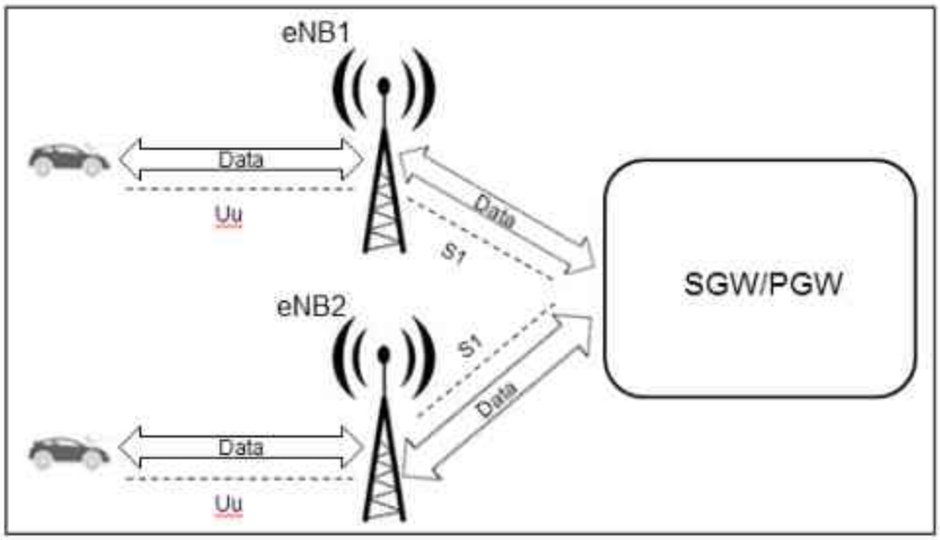


Fig. 6: Data Path in Rel-8 LTE

The cellular data path from UE to network and back to the UE introduces high end-to-end delay and does not meet the low latency requirements of V2X. Hence to reduce latency, Sidelink Communication feature is used for time sensitive V2X applications. In Sidelink communication, UEs communicate directly with one another via the new PC5 interface without the need for a network between them (Fig. 7).

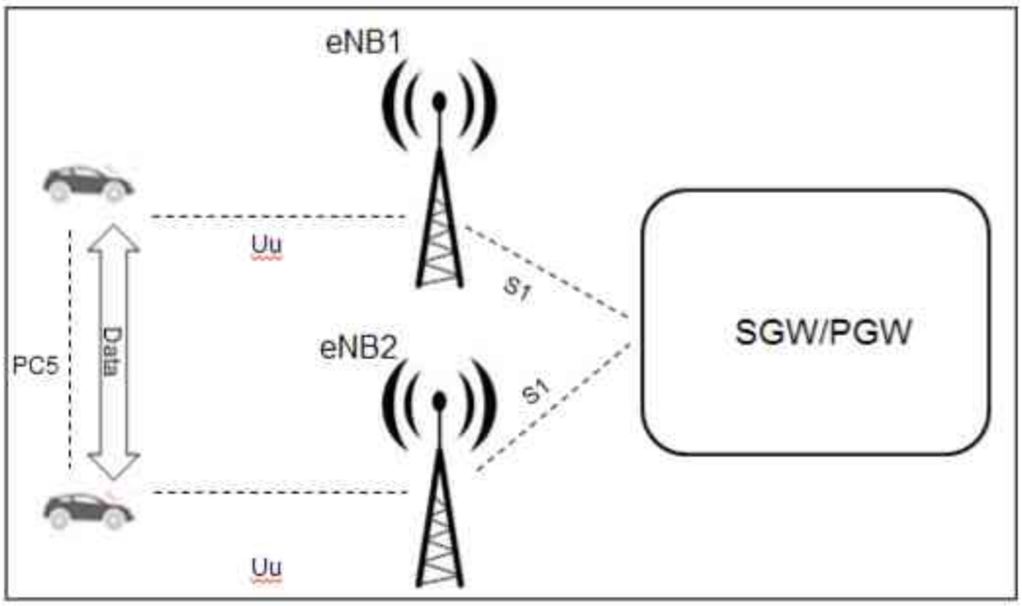


Fig. 7: LTE Sidelink Data Path

8.3 Scheduling

Scheduling refers to the allocation of radio resources to devices for communication. There are two modes of scheduling in V2X - Scheduled mode and autonomous mode.

Scheduled mode can be used only when UEs are under network coverage. In this mode, UE requests E-UTRAN to allocate resources for sidelink communication. E-UTRAN then allocates the exact time and frequency resources to be used by the UE for data and signaling. E-UTRAN can also allocate resources using semi-persistent scheduling. This further reduces latency.

Autonomous mode is used when UEs are not under network coverage. In autonomous mode, UEs select radio resources from a pre-configured resource pool. This resource pool can be provided either by the V2X control function when the device was in network coverage, or it can be pre-configured in the USIM.

8.4 Frame Structure

Typically, LTE UEs use SC-FDMA for uplink transmission and OFDMA for downlink reception. In V2X communication, UEs use the uplink SC-FDMA frame structure of LTE for both sidelink transmission and reception as SC-FDMA has lower PAPR than OFDMA leading to better power efficiencies at the UE side.

Secondly, additional Demodulation Reference Symbols (DMRS) are added in the frame structure to make it suitable for vehicular communication. DMRS helps receivers estimate the channel response properly. In legacy LTE, there are 2 DMRS in each subframe with an interval of 0.5ms. In V2V, the carrier frequency (fc) could be up to 6GHz and the maximum relative velocity (v) can be 280km/h. Doppler frequency shift (fd) is $\frac{(fc * v)}{c} =$ 1556Hz. And the coherence time $Tc = \sqrt{9*\frac{fd}{4\grave{A}}} = 0.27ms.$

Coherence time is the time duration over which the channel impulse response is considered to be not varying. The time interval of 0.5ms between DMRS in legacy LTE is larger than the coherence time of V2V and hence may not be enough to estimate the channel response properly. Hence V2X subframe for PC5 interface has 4 DMRS symbols at an interval is 0.21ms, which is less than coherence time. This makes LTE V2V work robustly at high speeds in ITS band.

Fig. 8: DMRS symbols in V2X Subframe in PC5 Interface

9. Performance Comparison of WAVE and LTE V2X

Effect of Load on Latency: Simulation experiments to evaluate the performance of IEEE 802.11p were carried out by Khairnar & Kotecha (2013) and Bilstrup et al. (2008). The results show that performance of IEEE 802.11p in terms of channel access delays degrades severely at high loads. If the load is very high, some nodes achieve successful channel access only 16% of the time. A comparison of WAVE and LTE V2X latency as a function of load was done by Hameed Mir & Filali (2014). These results also show that as the number of vehicles increases, the end-to-end delay increases drastically in WAVE. Results for LTE V2X also indicate that latency increases with number of vehicles. However, it still meets the latency requirements of most of the V2X applications.

Table 2: Latency vs. Number of Vehicles (N) for an Average Vehicle Speed of 100Km/h

Technology	*N=25*	*N=50*	*N=100*
WAVE	~100ms	~500ms	~1400ms
LTE V2X	~10ms	~10ms	~42ms

(Hameed Mir & Filali, 2014)

Effect of Speed on Packet Delivery Ratio: It is shown by Hameed Mir & Filali (2014) that vehicle speed has a significant impact on the Packet delivery ratio (PDR) of WAVE. PDR is computed as the ratio between the number of received packets and the transmitted packets during the simulation time. In WAVE, as the vehicle speed increases, PDR drops to a great extent. However results show that in LTE V2X, speed has almost negligible effect on PDR.

Table 3: PDR vs. Speed when Number of Vehicles N=50

Technology	*20Km/h*	*60Km/h*	*100Km/h*
WAVE	~0.65	~0.45	~0.4
LTE V2X	~1	~1	~1

(Hameed Mir & Filali, 2014)

Effect of Communication Range: Packet reception ratio (PRR) of LTE V2X and IEEE 802.11p are evaluated as a function of communication range by Blasco et al. (2016). PRR is defined as the ratio between the number of vehicles that successfully received the transmitted packet and the total number of vehicles that are located in the given range. In both highway and urban simulation models, it is seen that LTE achieves significantly higher PRR than IEEE 802.11p. LTE achieves 90% PRR at a distance which is about twice the distance at which IEEE 802.11p can achieve the same PRR.

Table 4: Range at which 90% PRR is Achieved

Technology	*Urban Scenario (Vehicle Density: 2540 /km^2 Vehicle Speed: 15 km/h)*	*Highway Scenario (Vehicle Density: 62 /km Vehicle Speed: 140 km/h)*
WAVE	~55m	~200m
LTE V2X	~95m	~450m

(Blasco et al., 2016)

10. Conclusion

IEEE 802.11p based WAVE has been shown to perform well in sparse network conditions and it meets most of the requirements of V2X under low traffic loads and in short ranges. However as can be seen from Table 2 and Table 3, performance of WAVE deteriorates drastically with traffic density and vehicular speed. On the other hand LTE V2X performs better than WAVE even at high traffic densities and at high speeds. Moreover, LTE V2X is more reliable at long ranges compared to WAVE (Table 4). Hence, due to its better performance in terms of scaling, latency, range and reliability, LTE V2X appears to be a better solution for most of the V2X applications, especially for time critical safety applications.

References

Architectures, Challenges, Standards and Solutions. *IEEE Communications Surveys & Tutorials, 13*(4), 584-616.

Bilstrup, K., Uhlemann E., Strom, E. G., & Bilstrup U. (2008). Evaluation of the IEEE 802.11p MAC Method for Vehicle-to-Vehicle Communication. Vehicular

Technology Conference, 2008. VTC 2008-Fall. IEEE 68th, p.1-5.

Blasco, R., Do, H., Serveh, S., Stefano; S., & Zang, Y. (2016). 3GPP LTE Enhancements for V2V and Comparison to IEEE 802.11p, Paper number EU-SP0264, 11th ITS European Congress, Glasgow, Scotland, 6-9 June.

ETSI TR 102 638. (2016). Intelligent Transport Systems (ITS), Vehicular Communications, Basic Set of Applications, Definitions.

Hameed Mir, Z., & Filali, F. (2014). LTE and IEEE 802.11p for vehicular networking: A performance evaluation. *EURASIP Journal on Wireless Communications and Networking, 89*(2014).

Jiang, D., & Delgrossi, L. (2008). *Towards an international standard for wireless access in vehicular environments.* Proceedings of 67th IEEE Vehicular Technology Conference (VTC2008-Spring), Marina Bay, Singapore.

Karagiannis, G., Altintas, O., Ekici, E., Heijenk, G., Jarupan, B., Lin, K., & Weil, T. (2011). Vehicular Networking: A Survey and Tutorial on Requirements,

Khairnar, V. D., & Kotecha, K. (2013). Performance of vehicle-to-vehicle communication using IEEE 802.11p in vehicular ad-hoc network environment. *International Journal of Network Security & Its Applications, 5*(2).

R1-15660. (2015). Discussion on DMRS Enhancement for PC5-based V2V, ZTE.

3GPP TS 36.300. (2017). Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN), Overall description, Stage 2.

3GPP TS 22.185. (2016). Service requirements for V2X services, Stage 1.

3GPP TS 23.285. (2016). Architecture enhancements for V2X services.

GLOSSARY

Term	*Expansion*
CSMA/CA	Collision Sense Multiple Access/Collision Avoidance
DMRS	Demodulation Reference Symbol
EDCA	Enhanced Distributed Channel Access
ETSI	European Telecommunications Standards Institute
E-UTRAN	Evolved Universal Terrestrial Radio Access Network
FCC	Federal Communications Commission
ISI	Inter-Symbol Interference
ITS	Intelligent Transport Systems
LTE	Long Term Evolution
MME	Mobility Management Entity
OFDM	Orthogonal Frequency Division Multiplexing
PAPR	Peak-to-Average Power Ratio
PDR	Packet Delivery Ratio
PLMN	public land mobile network
PGW	Packet Gateway
RMS	Root Mean Square
RSU	Roadside Unit
SC-FDMA	Single-carrier Frequency Division Multiple Access
SGW	Serving Gateway
UE	User Equipment
USIM	Universal Subscriber Identity Module
V2X	Vehicle to Everything
WAVE	Wireless Access in Vehicular Environment

Article can be accessed online at http://www.publishingindia.com

IoT Strategy for Telcos: Critical Success Factors to Win in the Changing Business Landscape

Praveen Arora*, Rakesh Mawa, Vikas Diwvedi***, Kabir Kathuria****, Nitin Sharma*******

**Director, Digital Strategy & Transformation, Ericsson, India. Email: praveen.arora@ericsson.com*

***General Manager, Digital Strategy & Transformation, Ericsson, India. Email: rakesh.mawa@ericsson.com*

****Senior Manager, Digital Strategy & Transformation, Ericsson, India. Email: vikas.diwvedi@ericsson.com*

*****Senior Manager, Digital Strategy & Transformation, Ericsson, India. Email: kabir.kathuria@ericsson.com*

******Manager, Digital Strategy & Transformation, Ericsson, India. Email: nitin.c.sharma@ericsson.com*

Abstract

The term Internet of Things (IoT) has been a buzzword for past few years with analysts claiming this to generate up to $11T in economic value by 2025. In the search of these economic benefits, Telcos have experimented with IoT with varying degrees of success. This paper gives a view of changing business landscape with the advent of IOT and discusses the critical success factors required for Telcos to succeed. With the help of concrete examples, the paper will answer questions such as – Why is the IoT market different; Why do the Telcos need to offer services beyond connectivity; What key changes are required to capture value across IoT value chain.

The paper argues that Telcos will need to take decisive steps along 4 key dimensions – Strategic Focus, Organizational Realignment, Partnership Orientation, and Technology Selection – to establish themselves as a successful IoT service provider. The paper provides evidence via failed IoT initiatives of pioneering Telcos and the changes made along these dimensions to be successful. The paper also gives a summary of latest initiatives by world leading Telcos and proposes a holistic approach to turn a Telco into a successful end-to-end IoT service provider to capture maximum value in the IoT market place.

Keywords: Internet of Things, IoT Strategy for Telcos, IoT value chain, IoT success stories, IoT Access

1. Introduction

Internet of Things (IoT) has become one of the most discussed segments of the ICT industry during the past few years. Numerous research firms have quantified the opportunities brought about by IoT and have projected significant market sizes. Gartner projects $1.9T market size by 2020 (Gartner, 2013), while McKinsey projects $11T in value add to the societal impact (Manyika, Chui, Bisson, Woetzel, Dobbs, Bughin, & Aharon, 2015). Similarly, Ericsson forecasts the number of IoT connected devices globally to grow 3x – from under 5B in 2016 to 16B by 2021 (Ericsson, 2016).

Fig. 1: Significant Opportunity for Telcos

Telcos have been providing connectivity services, which is one of the important building blocks for IoT services. Therefore, Telcos have an important role to play in the IoT ecosystem and the potential to ride this inevitable tsunami of IoT. However, analysts suggest that connectivity would provide only 10-15% of revenue in the entire IoT value chain. Most IOT solutions are expected to be bespoke with evolving scope, heavy SI, and will require multiple partners to put the solution together. Telcos have minimal experience in dealing with such solutions and also in working with Enterprises. Besides, traditional Telco organizations & their business dynamics are significantly different from the emerging organization structures needed for IOT services, as illustrated in figure below:

Fig. 2: Traditional Telco Organization vs. Emerging Organization Structures

Consequently, to succeed in IOT market, Telcos need to re-align their strategy and approach to fulfill the requirement of IOT services.

In this paper, we suggest a prescriptive execution-oriented process for a Telco to re-align its strategy, become an end-to-end IoT service provider and capture much larger piece of the pie.

2. Related Works

Research and analysis firms have done multiple studies on IoT eco-system and Telco IoT strategies. For example, Machina came out with an IoT Communications Service Provider Benchmarking in 2016 capturing details of IoT strategies of various Telcos globally (Chua & Hatton, 2016). Frost and Sullivan published European IoT operator profiles in 2016 (Frost & Sullivan, 2016). Analysys Mason published 'Operator Approaches to IoT', which analyses the role Telecom Operators can play in IoT market (Rebbeck, 2017). Most studies so far either document IOT approaches that Telcos have adopted, analyze their strategy or highlight different roles Telcos can play. As a result, they are mostly backward looking and address part of the overall approach required.

The analysis and recommendations presented in this paper go a step further, and provide a methodological step-by-step end-to-end approach spanning strategy setting to executable steps on ground to make the strategy happen. It also addresses the most important asset that Telco has – the Network – which most other studies omit.

3. Research Methodology

A three-pronged approach has been adopted for research and drawing out results of this paper:

- Analysis of multiple analyst reports in depth.
- Detailed analysis of the approach adopted by successful IoT players.
- Drawing out in-sights from live IoT/M2M Consulting engagements of the authors.

Specifically, we studied IoT value chain, IOT revenue projections, common attributes from Telcos' IoT initiatives, and success factors of Telco competitors & peers. Based on this analysis and practical knowledge gained by working with world leading Telcos, we came up with the four-step process documented here.

The suggested steps here can be adopted as skeleton to define the IoT roadmap of a Telco. Specific tools and frameworks for each step can be used as per the operating environment and intended objective of a Telco.

4. Results and Findings

Based on deep-dive analysis of IoT market, our understanding of traditional Telco business & Telco organizations, IoT success stories, and our practical experience, we have been able to come up with the following tangible four-step process for Telcos to identify their IOT strategy to and to potentially become an end-to-end IoT service provider, as applicable. The four steps involve refinement across:

- Strategic Focus
- Organization Realignment
- Partnership Orientation
- Service Aligned Network

Fig. 3: Process to Define Telco IOT Strategy

4.1 Strategic Focus

To define an actionable IoT strategy, Telcos need to take two key steps. The first step is to identify the key verticals and the key applications to pursue. The second step is to determine the role in the value chain of the select verticals/ applications. Each step requires rigorous analysis & stakeholder alignment to define the right strategy for the Telco.

4.1.1 Step 1: Vertical / Application Selection

Five key factors are the decision enablers for this step, namely external market dynamics, internal capabilities, regulatory trends, entry barriers and telco addressable revenue. These factors help Telcos identify key verticals / applications that are most favorable for them considering their strategic priorities, market reality, and those that can also be supported by internal capabilities.

To arrive at the result of focus verticals/applications, each factor needs to be broken-down into sub-factors; each vertical/application needs to be evaluated on each sub-factor and the factors then need to be brought together in an evaluation or prioritization framework.

To illustrate this further and make it tangible, we break down two key factors, namely External Market Dynamics & Internal Capabilities, and show a typical prioritization process and the outcome of such an exercise.

The key sub-factors for External Market Dynamics & Internal Capabilities are:

The above parameters are rated on a weighted scale to arrive at rankings and help prioritize the select applications. Various 2x2 matrices can be prepared while doing this exercise to evaluate the intensity and impact of key variables on the prioritization. Typically, no. of cellular connections, growth rate of the opportunity, addressable market and ease of implementation are variables that are considered during decision making. Additionally, the split of the addressable market into connectivity, solution/SI and device market size are also considered, in some cases.

Table 1: External & Internal Factors for IoT Application Selections

External Market Dynamics	*Internal Capabilities*
Overall Market Opportunity expressed in multiple forms such as revenue, connections, ARPU, profitability, etc.	Solution Development Complexity to develop and launch an IoT service
Competition from Telco as well as non-Telco players	Sales and Marketing Complexity to sell and market an IoT service
Fragmentation in the market in terms of the no. of buyers	Delivery Complexity to deliver & support an IoT service
Market maturity based on IoT service adoption and penetration	Network Readiness for the new requirements
Other factors such as existing customer relations, existing sales channels, delivery & support channels	

Similarly, for each IoT service and market, Telcos will need to look at Regulatory compliances as well as the maturity of the compliances.

Following figure summarizes the key evaluation criteria for Telcos to offer targeted IoT services in a market along with a sample 2x2 matrix of number of cellular connections and application revenue.

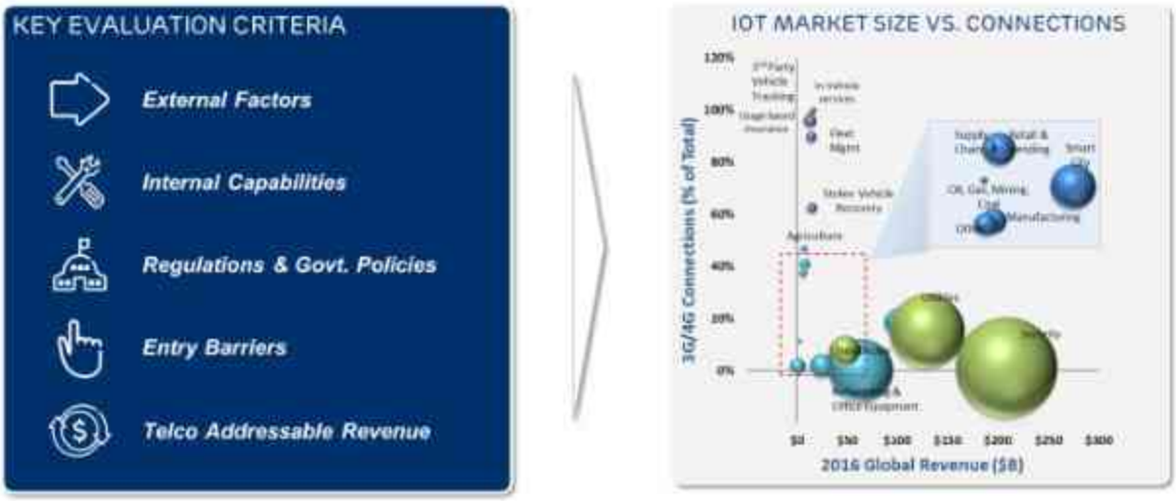


Fig. 4: Strategic Focus - Market Selection

Based on the above 2x2 matrix, there could be three categories of IoT applications that a Telco can potentially target:

1. **Mobile Applications:** Applications in verticals such as automotive have a high number of cellular connections, and they are low hanging fruits for Telcos. It is easy for Telcos to establish a leadership position in this space based on their current capability of mobile networks.
2. **Mature Applications:** More mature applications such as Healthcare, Utilities, and Security remain a priority due to the revenue potential and a large number of connections. These applications present a good revenue opportunity even if a Telco captures even a small pie from the total revenue.
3. **Strategic Applications:** There are set of applications where existing revenue is not significant and connections are not primarily cellular, however, these applications have high growth potential and remain a question of choice and strategy for a Telco. A telco can strategize to enter some of these industry verticals based on their internal capabilities, external market environment, and strategic focus.

4.1.2 Step 2: Determine role in the value chain

Based on the market assessment and application selection, a Telco needs to identify what role it should play in the value chain specific to each IoT application selected. This in turn defines the size of the market that is addressed by the Telco i.e., higher the role assumed, higher the market addressed and the returns and vice versa.

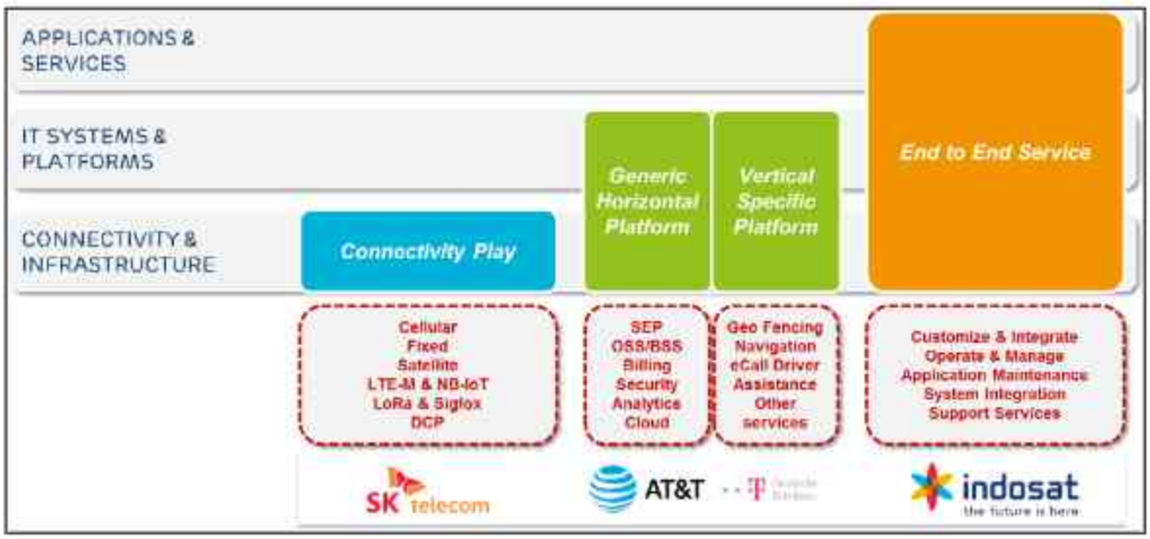


Fig. 5: Value Chain Role

As shown in the above figure, there are 3 main layers - Connectivity & Infrastructure, IT Systems & Platforms, and Applications & Services. Telco needs to figure out its role and idenfity its play in the value chain across each layer.

- **Network Developer** (Connectivity Play): Telco only provides connectivity for the IoT service
- **Service Enabler** (Generic Horizontal Platform & Vertical Specific Platform): Telco provides a platform or a set of value-added services in addition to connectivity that enables other players to get APIs for easy application development
- **Service Creator** (End to End Service): Telco itself provides end-to-end IoT service that includes Connectivity, Application, System Integration, Support Services, and other related services to consumers

4.2 Organizational Re-alignment

Traditional telco business has been different from the IoT business, and if a telco wants to become an end-to-end IoT service provider, it becomes imperative to realign the organization to suit the new business model.

4.2.1 Principles for Organizational Realignment

To become an end-to-end IoT service provider, Telcos shall realign their organization design around 4 key principles, as illustrated in Figure 3:

Fig. 6: Principles for Organizational Realignment

First principle for organization realignment is Innovation. To develop new and useful solutions in the evolving IoT space, Telcos need to develop a start-up like culture, i.e. focus on outcomes, defying hierarchy, idea generation, and small teams working in collocated spaces etc. However, it could be difficult for big Telcos to change the organization DNA, and hence they will need to take a series of steps to achieve it - one of which could be to have a dedicated IoT organization within the larger organization.

Second, principle is Agility - IoT solutions require experimentation with customer requirements and would require continuous feedback from the market. Making an Agile organization or an agile IoT entity would be required to succeed in the IoT market. For Telcos, this would mean enabling the organization with a set of lean processes and tools to get this feedback and enabling the organization to act on it during sales as well as delivery, so as to increase both revenue and profitability.

Effective management of Partnership eco-system is the third critical element to succeed in IoT market place. It involves not only making 'right' partners for solution design, sales and market access, but also bringing into fold innovations from open source communities, developer communities, and partners.

Finally, the fourth component is talent management. IoT is a new phenomenon and eco-system is being developed. There is a limited talent pool that everyone will need to

dip into. In addition, the current in-house talent of a telco needs to be evaluated and aligned to IOT market needs. Skills would be required around the complete lifecycle i.e. product design, pre-sales, sales, and delivery of IoT solutions.

4.2.2 Pillars for New Organization Design

Based on the four principles mentioned above, a Telco needs to take tangible steps on the ground, to make changes to organization design, sales process, teams, and service delivery.

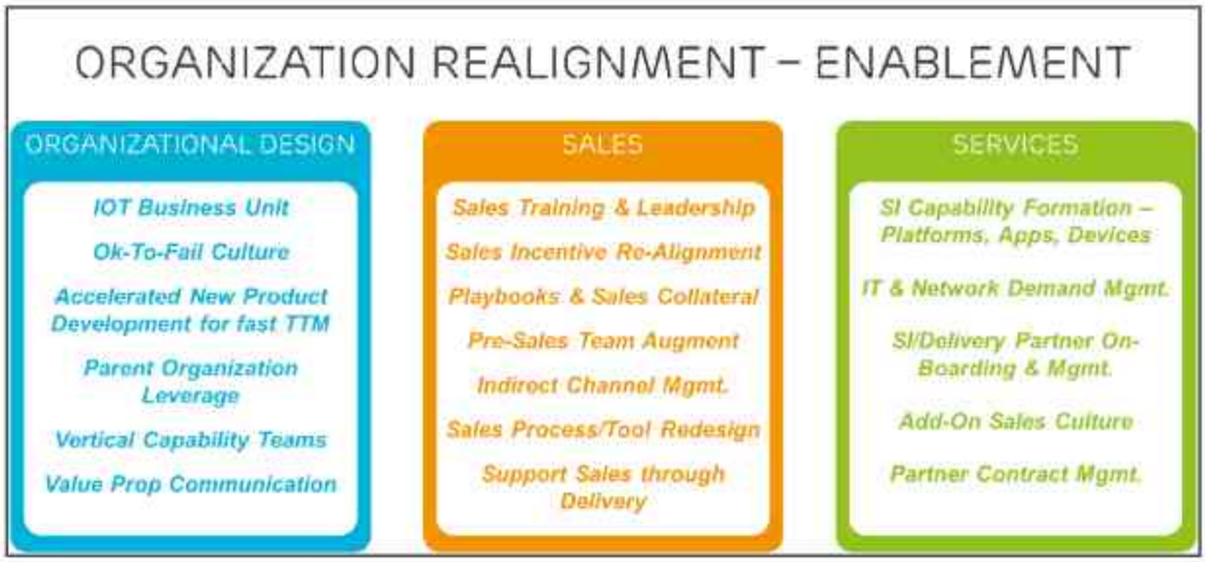


Fig. 7: Three Pillars for Organization Realignment

To enable innovation and agility and to keep a sharp focus, Telcos would need to setup separate IoT unit with a tolerance for failure, but one that can bring out new solutions quickly. To ensure this, the unit should not be created as a silo, but will need to have good alignment with parent organization. Hiring the right leadership with domain competence will be critical at every stage of the new product lifecycle. In addition, Telcos would really need to communicate these value propositions clearly in the marketplace to attract the right kind of talent.

The second key step they need to take is to enhance the sales organization – given that Telcos are entering the area of evolving SI heavy IOT solutions, they need to ensure that their sales teams are able to spot and sell these opportunities. This requires reskilling sales team, realigning their sales incentives, and giving them new playbooks to help pitch new solutions. Also, given the evolving and SI heavy nature of IOT solution, there is considerable amount of risk in development and delivery of such solutions. Telcos need to have new set of processes and tools along with a pre-sales team to minimize these risks.

Finally, the third area is Services – Telcos will need to bolster their SI skills by at times in-house development of platforms, applications and devices, and by ensuring that requirements of these applications are fed into network organization as well. Given the diversity of IOT solutions, evaluating and on-boarding various kind of development, delivery and service partners will be key. Finally, to ensure profitability, 'add-on sales culture' i.e. identifying upsell opportunities during delivery as well as 'partner contract management' e.g., having back to back agreements, is going to be key.

For example, AT&T is a good example of a Telco which has focused and produced results in IoT market. It has about 500 dedicated resources for IoT solutions along with similar number of support staff (Chua & Hatton, 2016). It has 6 foundries so far, with each foundry focusing on innovation for specific verticals (AT&T, 2016), e.g. foundry in Atlanta is focused on connected cars and that in Houston focuses on healthcare segment. They are leveraging partnerships two ways, firstly by partnering with enterprises such as Cisco and Texas medical center to establish these foundries; and secondly by supporting innovators and start-ups through these foundries to bring out new solutions. These foundries are a playground to succeed and fail, and finally work with the incumbent organization to bring the solutions to market. AT&T has dedicated sales resources for IoT solutions and also trains its existing sales force to sell IoT solutions. Similarly its

IoT team has focus on services and integration as they are leveraging partnerships as well to provide the services.

4.3 Partnership Orientation

As Telco's transition to become an end-to-end IoT service provider, third-party collaborations with OTT and other providers would become increasingly important.

An end-to-end IoT solution requires expertise in different value chain segments, including connectivity, platforms, IT systems, Application, and Services. Each segment has established players with experience and knowledge of their respective segments. As such, telcos will need to retool their partner management strategy and invest in systems that allow for the seamless onboarding of new IoT partners. In addition to enabling partner on-boarding & settlement tools for connectivity related services, developer outreach will be a greater focus as operators try to drive usage of their IoT platforms and infrastructure, and to gain a greater understanding of potential new IoT use cases across a broader range of industries – with a further side benefit of bringing some "start-up spirit" into operators' own businesses.

4.3.1 Partnership Imperatives

IoT solutions are complex and bespoke solutions, and require good service integration capabilities. The solution complexity requires different partners with deep expertise in their respective competence areas. Some of the considerations that are important to note while selecting M2M/IOT partners are:

- **Connectivity:** In order to offer a seamless IOT experience, wide connectivity is required, wherein devices can stay connected even if you roam in different geographies. Telcos often choose partners that help provide regional/global connectivity services using global SIMs or inherent platform capabilities.
- **Platforms:** There are platforms such as Axeda, Predix, Watson etc., and they can be leveraged to provide an e2e solution instead of building one of your own.
- **Vertical Expertise & Application Development:** IoT applications require the understanding of vertical markets along with application development capability. Certain partners provide this differentiation owing to their vertical experience and targeted development capability.
- **SI:** Taking the IoT services to customers requires service integration capability, and SIs play important role in integration, support, and maintenance of the IoT solutions.

It becomes necessary to on-board partners to deliver an end-to-end IoT solution. These partnerships are required for varied objectives such as value chain expansion, handling solution complexity, addressing market uncertainty, expanding market reach, specific vertical market expertise, and / or market making.

4.3.2 Partnership Dimensions

Based on the above mentioned imperatives, partnerships can be categorized into three main categories:

Fig. 8: Types of Partnerships

1. **Horizontal Partners** for building capabilities across IoT value chain segments e.g., AT&T and IBM partnership, where AT&T would develop apps on IBM Watson. AT&T also joined hands with AWS to develop IoT solutions in analytics and security space.
2. **Vertical Partners** for expertise in specific verticals e.g., AT&T partnered with GM for connected cars, where GM included LTE connectivity on all of its 2015 models and beyond. As a result AT&T maintained a strong leadership position in North American market in the connected car segment.
3. **Reach Partners** to increase geographic footprint and explore new sales channels e.g., Vodafone has over 50 partner operators to enhance its connectivity footprint. Partners include the likes of TDC Denmark, MTS in Russia, and China Mobile.

Partnerships need to be done after careful consideration of Telco's internal strengths and market dynamics. Right partner selection and onboarding would be a key success factor for a Telco to offer new services and become an end-to-end IoT service provider.

4.4 Service Aligned Network

It's not only the strategy, organization, and partners that the Telco needs to manage but they also need to work on their networks. The demands on the next generation of networks are not going to be met with a linear change over the current state of the networks. 5G is catalyzing innovation across key areas such as mobile technology (radio, low latency, high-density transmission; core networks and management software; mobile devices); real-time analytics; edge-of-network datacenters; and new (and still to be determined) applications and services such as semi-autonomous vehicles, augmented reality and IoT.

In this emerging environment, as IOT market matures, it is expected to be divided into two main categories namely:

1. **Massive IOT:** Very large number of devices, typically sensors & actuators; extremely low device cost and consume very low amounts of energy to sustain long battery life. Examples are fleet management, environmental monitoring and smart buildings. Device densities could be as high as 200K devices/ km^2
2. **Critical IOT:** Applications such as traffic safety/ control, control of critical infrastructure and wireless connectivity for industrial processes, require very high reliability and availability and very low latency. Low device cost and low energy consumption is not as critical e.g., lifeline communications. The requirement for low-latency services and the need to support local IOT applications (and others) will drive the need for more local processing and storage. This in turn will drive the need for more, smaller edge-of-network datacenters and better software to manage distributed workloads.

Both, Massive or Critical IOT applications will require very different Grade of Service (GoS) from the network. So, the question is how does a Telco design a network that supports such diverse requirements.

Additionally, step changes in System and User device KPIs, typically order of magnitude improvements in throughputs, latency and reliability, the demands on Networks, also on its flexibility and programmability are driving the network evolution. A dense small cell urban HetNet is mirrored by a network slice in its core to cater to such a high throughput Access, another Network Core Slice may cater to a single large Machine Type Communication (MTC) deployment (Telefonica IoT Team, 2015). The MTC requirements on the Grades of Service required from the network will vary greatly from Industry to Industry and the flexibility of the network to cater to newer and innovative Use Cases will be the key driver for the Network Evolution. In our view, Telcos would need to make strategic choices so that the Network is capable of meeting different GoS without getting locked into a particular Service based Architectural choice.

The diversity of architectural options that are available to the Telco is summarized in Figure 8:

Fig. 9: Diversity of Architectural Options

At a broad level, what this means is that future Networks would need to have a fine balance of Federation and centralized control. Some key Examples of such federated "network of networks" are Smart metering "slices", and V2V networks. Each of these networks is a specialized network servicing a set of Use Cases that have common QoS requirement. Telefonica UK has deployed such a network "slice" in UK, which is the largest of such an initiative globally (Cary, 2016). This is also a case for a network of massive "capillarization", meaning connecting massive number of devices (with low data rates) yet aggregating to significant signaling nodes.

We also see Telco as the provider of networks and orchestrator of such networks irrespective of Radio, Fixed, Microwave access i.e. Access Agnostic network orchestrator. Increasingly the Access control and management will move away from the Telco realms to public and even private provider realms. The key design principle of the Network design would be the capability of Programmable QoS delivery and providing the agility of the near real time changes by End User regarding their charging and service bundling.

Two key challenges in the path to the realization of the Service Aligned Network are: One, many of the technologies, such as the New Radio (NR) (Flore, 2017)

aren't defined as yet and secondly, wherever the technology standards are defined, these are not harmonized across the Standards Bodies. The disparate standards have their own priorities and timelines. As a result, standard bodies have lagged, while market has made bets and moved on. This phenomenon has led to development of a heterogeneous set of Chipsets/modules/core technologies that do not seamlessly interwork with each other. The challenge for Telcos will remain to make technology choices which are still not matured without locking themselves in.

This has led to some of the operators making big bets to sway the market – e.g., The US operators / FCC 28GHz positioning in USA or SKT in Korea are examples of local/regional drivers taking precedence over globally harmonized ecosystem in IoT.

Regulations need to evolve with the market and industry - In addition, new suppliers and standards may yet emerge, especially using unregulated spectrum.

5. Conclusions and Future Works

With the traditional connectivity business stagnating, Telcos are trying to diversify into new & growing revenue streams such as IOT. It is imperative for Telcos to determine their play in the IoT marketplace. In this paper we have suggested a step-by-step approach that can be adopted by a Telco to become a successful end-to-end IoT service provider. The suggested approach is based on a robust methodology where we have analyzed multiple analyst reports in depth, studied successful players, and also drew from live consulting engagements.

The paper recommends that Telcos need to focus on four key pillars to re-orient themselves to become an IOT service provider namely Strategy, Organizational Realignment, Partnerships, and Service Aligned Network to deliver on the new services.

IOT strategy helps identify key verticals & applications to pursue and the role that Telcos need to play in the value chain. Organizational Realignment guides Telcos to redesign their organization on 4 key principles – Innovation, Agility, Eco-System Management, & Global Talent. Based on these principles, actionable changes in the Organizational Design, Sales Process, and Services Delivery are suggested. Partnerships are categorized into 3 types – Horizontal, Vertical, and Reach, which are selected based on Telco's internal strengths and market dynamics. Lastly, Service Aligned Network - networks are increasingly becoming a mix of federated autonomous network of networks that cater to different Use Case Categories. Given the complex and heterogeneous non-harmonized environment of Standards and consequently the entire ecosystem of Products/Services, the Telecom Network will always need to be flexible to adopt/support new Access Technologies and should be able to integrate with the respective ecosystems. They will have a Network of Networks to meet unique gas requirements and a Centralized Control that is fertilized and connected via a shallow hierarchy by leveraging various techniques such as RAN centralization & virtualization.

Thus, this whitepaper offers a holistic approach to turn a Telco into a successful end-to-end IoT service provider to capture maximum value in the IoT market place.

As IoT Standards, technologies and ecosystem mature, we propose to study how the technologies like Machine Learning, Advanced Business, and Network Analytics influence the Telco Evolution. We propose to build a framework of "Digital Maturity for IoT" of Telcos which will indicate the capability of Telco on different dimensions ranging from capability to provide fine grain GoS to devices, to near real time self-care to customers.

Execution of IoT strategy for Telcos also remains a future area of study. Supporting processes, best practices, and issues, specific to IoT solutions, needs to be studied and identified for on-boarding process, contract management, carrying out POCs, creating effective marketing collaterals, product / solution development, and pricing.

References

AT&T. (2017). AT&T Foundry At a Glance. Retrieved from http://about.att.com/innovation/foundry

Cary, C. (2016, March 31). Developing a Strategy for Telcos to Monetize IoT. Retrieved from https://www.ovum.com/research/developing-a-strategy-for-telcos-to-monetize-iot/

Cary, C. (2016, January 29). Telcos must reform their partner strategy to excel as DSPs. Retrieved from https://www.ovum.com/research/telcos-must-reform-their-partner-strategy-to-excel-as-dsps/

Chua, G., & Hatton, M. (2016, September 26). Internet of Thing (IOT) Communications Service Provider Benchmarking 2016. Retrieved from https://machina-research.com/report/internet-of-things-iot-communications-service-provider-benchmarking-2016/

Ericsson. (2016, June). *Ericsson Mobility Report.* Retrieved from https://www.ericsson.com/res/docs/2016/ericsson-mobility-report-2016.pdf

Flore, D. (2017, March 9). 5G-NR workplan for eMBB. Retrieved from http://www.3gpp.org/news-events/3gpp-news/1836-5g_nr_workplan

Frost & Sullivan. (2016, November). *European IoT Operator Profiles – Part 1* (Publication No. MC11-67). CA, USA: Frost & Sullivan.

Gartner. (2013). Gartner Says Personal Worlds and the Internet of Everything Are Colliding to Create New Markets. Retrieved from http://www.gartner.com/newsroom/id/262101ng

Manyika, J., Chui, M., Bisson, P., Woetzel, J., Dobbs, R., Bughin, J., & Aharon, D. (2015, June). Unlocking the potential of the Internet of Things. Retrieved from http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/the-internet-of-things-the-value-of-digitizing-the-physical-world

NGMN Alliance. (2015, March). *NGMN 5G White Paper.* Retrieved from https://www.ngmn.org/5g-white-paper.html

Radicati, F. (2017, March 23). IoT acquisitions by TMT firms hit $93bn mark in 2016. Retrieved from https://www.ovum.com/research/iot-acquisitions-by-tmt-firms-hit-93bn-mark-in-2016/

Rebbeck, T. (2017, January 5). Operator Approaches to IoT: From Connectivity to Platforms and Full Solutions. Retrieved from http://www.analysysmason.com/Research/Content/Reports/Operator-approaches-IoT-Jan107-RDME0/

Telefonica IoT Team. (2015). Telefónica's UK Smart Meter Implementation Programme Deal. Retrieved from https://iot.telefonica.com/blog/telefonicas-uk-smart-meter-implementation-programme-deal

Article can be accessed online at http://www.publishingindia.com

Digital Disruption is Redefining the Customer Experience: The Digital Transformation Approach of the Communications Service Providers

Sanjay Shrivastava*

**Senior Consultant - CEM CVM Analytics & IOT, Digital Strategy & Transformation, Ericsson, India.*
Email: sanjay.shrivastava@ericsson.com

ABSTRACT

Digital disruptions are transforming Customer's Digital World. It includes co-occurrence and coexistence of intensely evolving digital technologies, the burst of distinct digital devices, different digital channels across the customer touch points and constantly evolving Customer Bahaviour. The communications industry is no exception and is impacted as well. Digital disruptions have triggered enormous changes in technology advances, intensified service experience by digital native companies and constantly changing customer's expectations, pushing Communications Service Providers (CSP) to embrace the constant change and offer personalized seamless Customer Experience. Digital Disruptions bring an opportunity for a CSPs to transform their complete ecosystem and be relevant to the digital aspiring experience hungry customers and retain their market position. CSPs must need to transform themselves into a digital company with digital competencies to manage the changing experience across the multiple touch points and embrace continually evolving customer's expectations through innovative digital products and services. CSP's traditional business models continue to decline and has a zero-effect. They constantly need to innovate a multi-model approach to retain or attract the todays self-organize customers and improve declining revenue. The enhanced customer experience creates a perceived customer experience value for their customer, and it leads to customer loyalty which creates a sustained business value or revenue streams for CSPs.

Customer-centric digital transformation enables CSP to adapt and an embrace digital technologies, know the customer insides, align the internal business operation processes and governance to offer a digital experience across all the digital touch points with a greater speed. It is termed here as Digital Customer Experience Transformation (DCExT). CSPs need to carve out transformational journey in-line with their business priorities while keeping sustainable digital maturity level and future digital evolution roadmap as recommended in this paper. For CSP, DCExT continuous journey to embrace the digital disruptions for their own sustainable and profitable growth and be significantly be relevant to their digitally enabled customers.

Keywords: Digital Disruption, Digital Customer Experience, Business Transformation, Digital Economy, Digital Maturity, Digital Transformation, Digital Proficiency, Communication Service Providers

1. INTRODUCTION

The Communication industry is continuing to change in the past couple of decades and Communication Service Providers are intensely following the ongoing digital disruptions created by the best of the Over-the-Top (OTT) industry segment companies or it is termed as Digital Native Companies. CSPs have faced tough challenges with digital native players to develop new and innovative digital products or services for the digitally disrupted customers. Todays digital customers or users are self organizing and expects an empowerment to manges their product or service subscription, usage or choice as per their changing personal or business needs. They are known as digital self-organize customers or subscribers. Digital native companies are continually expanding the scope of their offerings and it disrupts again the customer behaviors and expectations. The rapid growth in the disruptive digital technologies like Artificial Intelligence, Machine Learnings, Virtual and Augmented Reality have significantly influenced over the way people behave and think. The burst of different devices with distinct operating systems, including - Laptops, Mobiles, Tablets, or Wearables and usage pattern of smartphones has changed the customer's lifestyle. The personalized product or service experience expectations has changed the self-organized digital customer's activities, usage pattern, their digital interactions to meet their service needs, expectations from their CSPs. Customer experience management (CEM) dominates the CSPs strategic priority and 68% of Telecom top executives cites it's their number one strategic initiative and Priority as per E&Y research.

(Prashant Singhal, Holger Forst, Gaeron McClurem, Amit Sachdeva, Bart van Droogenbroek, Adrian Baschnonga, Swati Mahajan, EY, 2015). CSPs must need to harmonize traditional (voice) and multiple digital or on-line channels through which they engage with self-organize digitally enabled customers throughout their customer journey to enhance their digital experience.

Multiple Digital technologies like Data Analytics, Enterprise Mobility, Social Networks, Cloud Computing, Robotics, Block Chain and Internet of Things (IOT) are pushing radical change in the ways of working (WoW) of both retail or enterprise customer segments. CSPs need to transform themselves in incremental steps to align with these digital disruptions to create new revenue streams with constantly evolving multi-model transformation approach. To enhance the digital customer experience, CSP needs an organizational retrospection to produce the customer experience value and make a digital self-organize customer as part of their business value chain. Cross function modularization of business models with dynamic multi-modal approach is essential to establish the business value. It needs a transformation across the all the functions starting business, operation and technology to align with customer behavior through enhanced Digital Customer Experience which is the Digital Customer Experience Transformation (DCExT).

DCExT is a continuous and progressive journey towards the automated and collaborated digital ecosystem to improve the operational agility, offerings of relevant digital products offerings to enhance the experience in the world of digital disruption in a shorter time. DCExT is a modular lone solution to expand digital capabilities to adapt constantly changing business conditions in the digital disruptive environment. Its progressive phased approach depending upon the current digital maturity level of the CSP and their medium to long term business vision. These digital disruptions with combination of dynamic multi-model digital approach creates a new revenue opportunities through enhanced customer experience. Evolving different digital channels across the multiple smart devices using right combination of digital technologies and capabilities with aligned business operation assists the CSP to tailor themselves in a relatively short time to match with constantly changing behaviors of self-organize digital customers and retain their position in disruptive market.

2. Methodology

This study considers the multiple digital disruptions in evolving digital world and its impact to Communications Service Provider to define their digital customer experience transformation journey to suffice experience hunger of self-organized digital customers. Digital disruptions produce an opportunity for CSPs to embrace constantly evolving customer expectations through evolving multi-model business approach and explore new revenue streams as business value for them. It highlights the broader DCExT roadmap in the disruptive digital world to refine and define a digital journey for CSP, with the support of dynamic multi-models in order to be relevant to the digitally enabled self-organize customers those are highly influenced by various digital native or OTT Players with their user friendly offerings and touch point personalized seamless digital experience.

3. Human-Centered Evolving Digital World

Human's needs to continue to exist, however, those are going to evolve progressively with the constant change in their lifestyle and behavior. Although needs or wants are considerably analogous in the constantly evolving digital world in last multiple decades. Since the ancient ages - health, education, banking or finance, utility services, retail and transport are fundamental wants and attributes of the humans as shown in figure 1. Still, these are continuing, will going to exist in future as well.

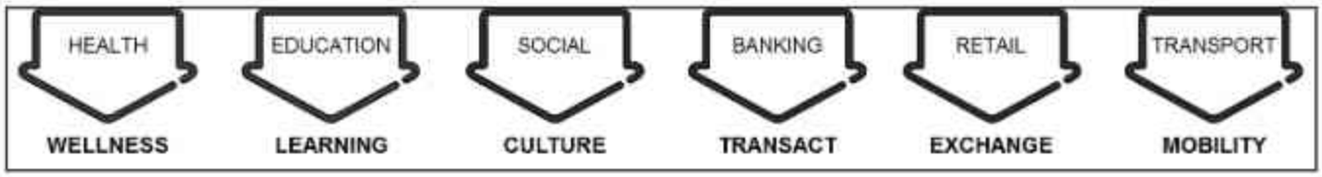


Fig. 1: Human's Needs or Wants in a Evolving Digital World

Present and 4th Industrial Revolution (Richard Samans and Nicholas Davis, World Economic Forum, 2017) is enabled by multiple digital technologies. These technological evolutions have changed our methods of communication, transport, healthcare, financial transactions or production, and also our social behavior. The telephone with the

spread of the internet and mobile telephony, including multiple evolution of digital communication once again changed how Human's move, communicate, consume and experience their world. It also have a combining effect and again transform the manner in which humans communicate, produce things, transport people or goods and interact. There is a transformation with radical change in the way Humans meet their needs or wants. Humans need an interactive, customize connectivity to meet their different needs. In changing scenario humans expect a real time financial transaction, instant healthcare service and anytime education access on the tip of their fingers., They expect a real time tracking, real time information access and freedom of mobility. In other words its complete 24*7 social or business engagements are the needs of todays digitally enabled humans.

Fig. 2: Digital Disruptors defines the New Ways to avail the Product or Services

The Disruptors, digital native companies like Amazon, Google, Uber, Netflix or AirBnB – they have established themselves as a digital service providers successfully. They offer digital products and deliver the services over digital interactions or channels.

In case of e-commerce industry segments, one can say - the customer doesn't see shops, don't hear the agent's voices and yet they get what they want. It's an amazing experience and sets the expectation for other to provide.

Referring to the music industry – from tapes to CDs to mp3s, Airline industry – from jacket tickets to e-tickets to mobile boarding passes. It means the products themselves are taking the digital form factors. Service touch points with the end customers are also becoming more and more digital.

CSP has a significant role in human's world as they provide the connectivity and enable humans to use or consume the different services to address from their wants (or needs) through interactive multiple channels(voice or digital). CSP can harmonize the customer interaction across all the digital touch points, simplify the service and offer a very personalized seamless customer experience. Digital Connectivity gets more and more integrated into Human's life. Disruptive ecosystem created by OTT players creates a hunger of digitally enabled customers beyond the voice or data services and are looking for an application ecosystem to address their daily wants (or needs). Smartphone proliferation is now revolutionizing the customer's lifestyle – people now have started leading a digital connected smart lifestyle.

4. Digital Disruptions and Its Impact on Customer Experience

Digital Disruptions are transforming the Customer experience. It includes co-occurrence of intensely powerful digital technologies, different digital devices, availability of multiple digital channels across the customer touch points and finally constantly evolving Customer Behavior as shown in figure 3. Distinct digital generations of the digital world disrupts the customer expectations and add complexity to maintain the uniform products and services offerings for the CSP.

Fig. 3: Digital Disruption

Digital disruptions are impacting user experience and CSPs must widely adapt the changes as a result of digital disruptions. Digitally enabled changes or a combination

of changes provides an opportunity to embrace it and be relevant for the Self- Organize Digital Customers.

4.1 Digital Technologies

Immensely powerful digital technologies enables the power of Digital Disruption. Constantly evolving digital world is experiencing an evolution of the multiple digital technologies. These technologies are directly impacting the customer's behavior and at the same time it challenges to the organization's digital capabilities and their product portfolio.

Advent of emerging digital technologies and limitation of the digital capabilities within an organization is changing the relationship between Digital Customers and Communication Service Providers. Digital technologies are altering how the customer experience value is created, exchanged and leveraged across the value chain for CSP.

Digital technologies are becoming crucial to the business and key innovations of the organization are based on the technology platform. Key digital technologies that are driving the consumer behavior transformation as indicated in figure 4.

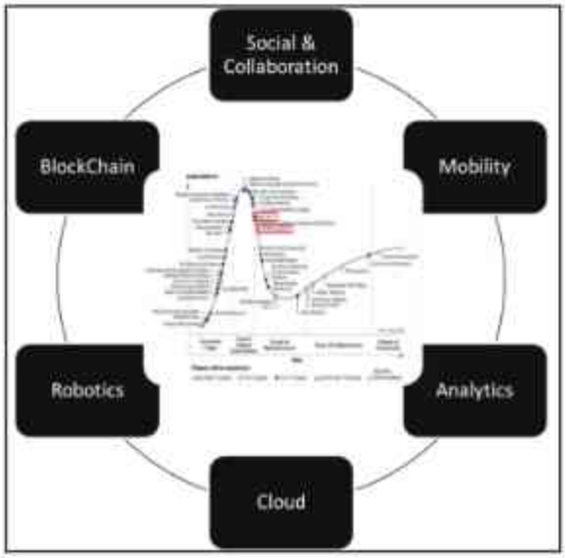


Fig. 4: Digital Technologies Evolution

Sources: Gartner Hype Cycle, Gartner.

In case of Analytics, it helps to venture the preferred channel journey analytics, it enables to identify the right offer for the right customers at the right time through their most preferred digital channel. Analytics is the future of any digitally transformed business of tomorrow and customer analytics is at the forefront. Data Mining and Date Ware House technologies define the new ways of managing the structured or unstructured data for customer inside analysis. Referring to Gartner's Technologies Hype cycle, it highlights the evolution of digital technologies over the period of time. Technologies like Big Data, Cloud, Augmented Reality, Virtual Reality, Data Science, Machine Learning and Analytics are essential for an organization to be digital. The combination of these multiple digital technologies has substantial impact on customer behavior and customer experience. It's evident that digital technologies are evolving and getting on the stage of maturity, however CSP's are hesitant to embrace constant evolution in the digital technology and disruptive effects. Disruption creates an opportunity for the CSPs to embrace technology disruption. It's significant for CSPs how quickly they adapt the digital technologies and address the disruption created by the digital native companies. DCExT needs a collaboration of functional organization silos and business management together enabled by the multiple digital technologies to drive digital customer experience of self-organize customers.

Although individual digital technologies were designed with a different objective, however, they become agnostics and can be applied in multiple ways. Digital technology disruptions needs an involvement to align the CSP's business working model and manage them effectively to refine the customer's digital experience through digitally enabled engagement. However a combination of digital technologies brings the new digital product offerings to suffice the experience disruptions created by Digital Natives like Amazon, Facebook , Uber or Air BnB.

4.2 Distinct Devices Abstractions

Multiple digital devices and mobility (-anytime & anywhere), needs are redefining the way self-organize customer interact within their digital ecosystem and use the different digital products or services. Ability to choose, the devices of choice like smartphones, tablets, wearable or computers to access the information or any digital service on the go is a normal trend. Customers wanted to have seamless engagements without any limitation of devices. Self-organize customer wants the freedom and flexibility to choose the device brand of their choice and continue their conversation across all the platform seamlessly.

Devices flexibility outlines the fundamental level of personalized customer experience across any device, any time and at any location in the world. Device abstraction becomes the customer need and it's become a digital disruption whenever a customer wanted to switch from the one device to another device irrespective of their operating systems or applications.

Fig. 5: Muli-Screen Engagements Across the Transformed Device Ecosystem.

Self-organize customer expects the omni channel(seamless uniform experience across all the devices and channels) engagement across the different devices or platform irrespective of their operating systems(Android, iOS, Mac OS X or Windows). There should not be any interruptions in customer's ongoing conversation through any of application like WhatsApp, Facebook or NetFlix through any of devices or screens regardless of their make or brand.

4.3 The Digital Channels

Self-Organize digital customers in the disruptive digital ecosystem have an expectations, those are well-established by the best of the forward thinking digital natives like Apple, Amazon or Uber. It transformed the customers' behavior and pushes greater choice around the interaction options. Digital customers are inclined towards the Digital Service channels from traditional voice centric call center interaction. There is need of personalized, immediate,uniform interaction and engagement experience across the multiple channels. It defines the expectation of the consistent experience level over any of the channel or combinations of channels used in the customer journey (Customer's interaction with CSP across the multiple touch points throughout their engagement). It's a new normal to have a uniform, seamless interactive experience across multiple channels like Inbound Calls, IVR, Walk-in, Mobile Apps, Portal, ChatBot, Social network or Social emails channels. Self-organize customers expect the sense of flexibility to choose rather than one fix dedicated channel of CSP's choice for all their interactions. Its default expectation of unified experience across all the channels engagements and moving ahead there will be scope of the preferred digital channel for superior personalized interactions. The Most preferred channel is nothing but *The Organic Channel* (channel of customer's choice or preferred).

Flexibility in channel selection as per changing preference is a big disruption for the CSP, however, it creates an opportunity to engage with customer effectively through the Organic Channel to boost their service experience. These multiple channels create a significant opportunity for CSP to create stickiness. Channel agnostic need pushes CSP to refine channel strategy in regular interval which is going to be the new normal in their business operation.

Fig. 6: Digital Channels

Sources: Image Ericsson (CLC)

4.4 Customer Behavior

Customer behavior is a constant change. Their expectations are increasing day by day and its complex to manage evolving expectations. Digital native like Amazon, Uber or Google along with Apple have caused notable deviations to customer behaviors and expectations.

Todays self-organize customers have experienced different ways of engagement with the digital natives and have a fundamental set of personalize experience expectation (Mike Ashton, CX Network, 2016) from their

CSPs as indicated below. The Customer expects real-time experiences 24*7 across all these fundamental attributes.

Seamless: Customer expects the seamless and effortless transactions through the digital or voice channels. For example Uber or Amazon uses single digital channel to engage or interact with customers and still their customer interaction is very smooth, efficient and easy.

Stimulating: Useful, interesting, or engaging information that can create value for the customer rather just selling or promotional product information. For example Healthcare apps 1MG provides relevant disease research information/data or health precautions notes to customer while customer engage with them within that online interaction. Its an attempt to build the trust and reputation along the way without any additional deliberate sales attempt.

Sensitive: Use of social channels to listen intently and develop an understanding of what really interests customers and CSP should respond in ways that are intelligent and relevant to customers. For Example Dell and Starbucks invite an idea from the customer and make them into reality.

Synchronized: Analyze and deploy the information across all the touch points, real time support and personalization in all the conversations between the Customer and CSP organizations. For example: FirstDirect customers mostly recommend their bank than customers at any other major Great Britan bank. Source: GfK FRS, 6 months ending June 2016. Seems they have uniform business rules across all the channels.

Smart: Align with trends and respond to technology-driven opportunities to keep the customer experience fresh and distinctive. For Example: Amazon, always keep themselves ahead with technology to boost the customer experience.

Constantly changing customer behavior pushes the CSP to exceed the customer experience standard created by these digital native digital companies or the disruptors. Personalization study by Deloitte suggests customers roughly around 20% are happy to share personal information with CSP to offer them a personalize products and services (Matthew Guest, Adam Stonell, Jane Schachtel, Heather Rangel, Jane Schachtel. Deloitte MCS Limited, 2016).

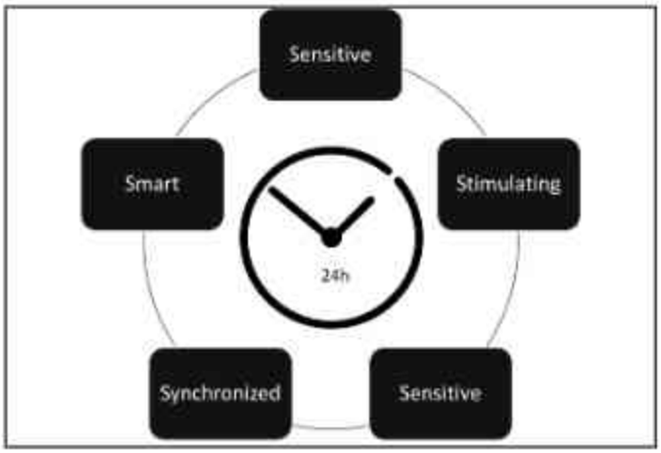


Fig. 7: Customer Bahaviors, Expectations and Experience 24 * 7

4.5 Digital Generations

Digital Body Language defines different generations of the digital world. It results from the collection of different online activities, interest, behavior and preferences of an individual customers through their digital or social channels. Digital body language defines the digital literacy or proficiency to segment the customers to offer them relevant products. In a digital world, distinct digital proficiency coexist and defines the new preference of channels beyond the traditional voice channels and applications. These are new generations of the digital world as shown in figure 8 and it add disruption for CSP to define and maintain their product offerings for these multiple digital literacies.

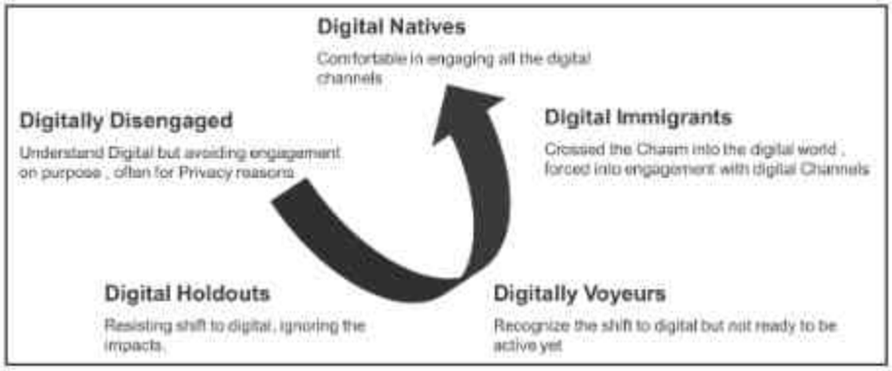


Fig. 8: Digital Proficiency Defines Distinct DCEx Needs

Source: Constellation Research

- *Digital Natives:* Enjoy and engage very comfortable in all the Digital channels.
- *Digital Immigrants*: Forced into engagement and crossed the span of the digital world.
- *Digitally Voyeurs*: Recognize the change to digital but less ready to be an active participant.
- *Digital Holdouts:* Resist to shift to the digital, also ignore the impacts of digital channels.
- *Digitally Disengaged:* Understand the Digital but reluctant to engage on purpose.

5. Digital Customer Experience is a Progressive and Continuous Journey

Digital customer experience needs a consistent effort to overcome various digital disruptions discussed in this paper relevant to the Communication Service Providers. Customer Experience is a long term strategic, progressive and continuous transformation journey for an organization. Hence its strongly linked with the business vision and mission statement of communication service providers. Business ambition of C-suite drives the long term strategy of CSP to make them a digital company and be relevant to self-organize customers those are disrupted by Digital Natives. The CSP must need to go through transformation changes in order to be customer centric, however its not a one-time or overnight activity. DCExT is a continuous improvement program and a long term strategic initiative in a phased manner. It also significantly reflects the changes are expected in the business model of CSP to adapt the digital disruptions and use it as an opportunity to transform and embrace the change to enable *"Customer is First"* culture in an organization to improve the long term business profitability.

5.1 Digital Customer Experience Maturity

For Digital customer experience transformation, it's essential to know starting junction which indicate the baseline of the Communications Service Provider in their customer experience maturity. Digital customer experience maturity assessment is the first step to know CSP's maturity level and starting point of their digital journey in order to be a digital company. It assists to formalize a proactive milestone based roadmap to achieve the next desired level.

Under the digital maturity assessment different business, functional, organizational, technological aspects need to assess to identify *Strength and Improvement Areas* of Communication Service Providers across the different digital levers (#7). Referring to Gartner's Customer Experience maturity framework (Ed Thompson, Gartner, Inc, 2011) these digital levers includes organizational vision, strategy, operations, matrices, governance, process and technology. The DCEx journey is specific for each and every CSP and depending upon where they stand in their digital maturity, they will have to create their long term Digital Customer Experience Transformation Roadmap.

Strength Area: It highlights the merits in which CSP has an extremely favorable customer experience, resources and business ecosystem is in place with respect to a defined specification of digital levers considered.

Improvement Area: It highlights the weak areas and CSP needs a major improvement efforts across all the digital levers considered with respect to defined specifications of maturity framework.

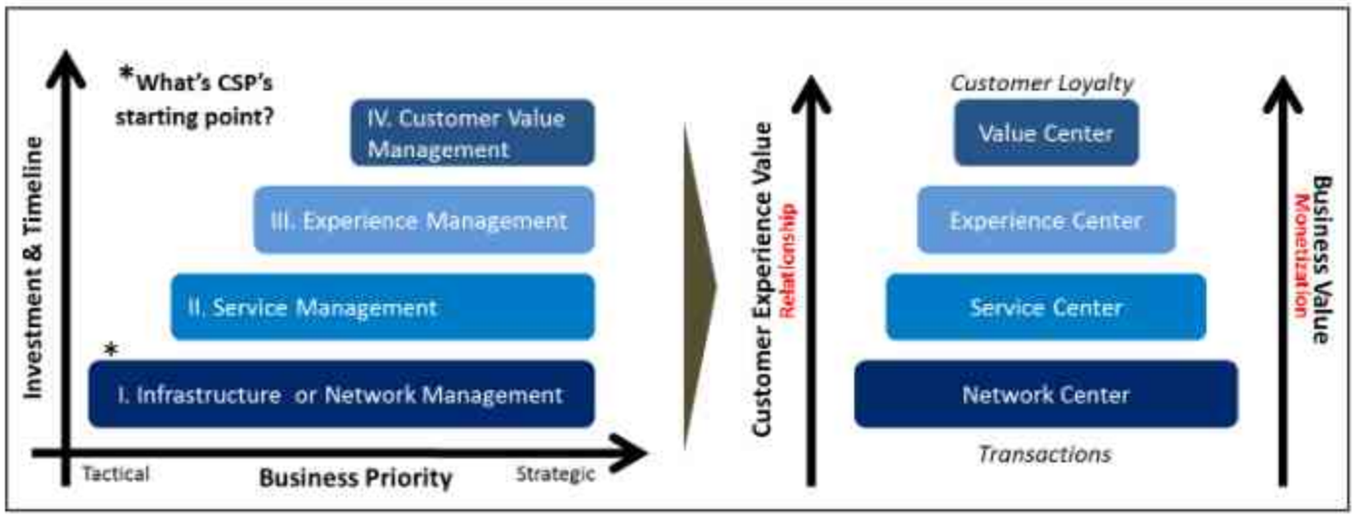
5.2 Digital Customer Experience Journey Map

Digital customer experience (DCEx) is a multi phase progressive approach to address disruptive needs of the Digital world and transform in a very integrated manner across the complete CSP organization by breaking all the functional silos (Top to Bottom and Horizontals) in the very structured model. The DCEx Transformation journey is a long term strategic program for a CSP organization and takes an approximate time period of 3-5 years to achieve positions as a Digital Service Provider. However, time period, predominantly depends upon the CSP managements or the C-suites, business priorities and how soon they want to adapt and embrace the digital disruptions in order to be digital organization. In addition, it also depends upon their present customer experience maturity level.

Business Priorities of CSPs motivates them to choose the best digital customer experience transformation roadmap for them. Digital customer experience is long term business priorities rather a short term tactical action. CSP managements must trade off between these long term and short term initiatives as per their changing business needs. There are different methods to measure the DCEx maturity of CSP, however, one of approach which is more practical and relevant for CSP is DCEx Maturity Journey Map, indicated in figure 9(a), the CSP must need to choose the best path as per strategic priorities, investment appetite and their present level in digital customer experience maturity. The Sequential progress or fast-forward (2 or more level at a time) jump in their digital experience

transformation journey, enable CSP to take head on with multiple digital disruptions. DCExT enables the CSP to be more agile, more proactive and competitive in the market through the relevant and targeted engagements with customers. It leads them for sustainable & profitable growth in the disruptive digital world.

Communication Service providers must need to go through structural model to adapt and implement the necessary changes across different digital levers considered (Ed Thompson, Gartner, Inc, 2011). DCEx needs an alignment of customer expectations, interaction across digital touch points, business processes and digital technology capabilities to make an organization more relevant and create an experience value for the self-organize digital customers.



(a) DCEx Maturity Journey Map (b) DCEx Value Realization

Fig. 9: DCEx Transformation Map and DCEx Value Realization

5.3 Digital Customer Experience Maturity levels for Transformations

5.3.1 Infrastructure or Network Management Level

Traditionally Communications Service Providers most prominently rely on the Network centric views through their network operations center(NOC), which is a network centric ecosystem. It's more of a tactical approach of an organization to streamline the network planning and its network field operations. In addition CSPs profoundly rely on network metrics provided by network operation centers to track the network performance and other derived metrics to monitor the end user customer experience. Here the primary focus is to monitor the network's technical functionality and faults at the infrastructure level. It enables network fault monitoring and reactive trouble shootings once fault is reported back or identified by the centralized operation center. Traditionally CSPs have a tendency to link network operation and its management with the Customer Experience. It looks into the basic need of network connectivity or network coverage. CSPs focus significantly on network capacity planning and network rollout. Customer experience gets trapped between these two and TSPs look for means of managing this network service, issues and connectivity as a measure of customer experience with main focus on network capacity and coverage.

5.3.2 Service Management Level

Service Management layer monitors and manages the service performance and provide Service Centic View, beyond the reactive network entity or node level analysis. The Service operation center (SOC) provides a real-time view of the each and every service their customers are using for examples Voice call or data web browsings. Here service assurance is key and followed through service performance parameters like delay, latency, speed or throughputs in the case of the data services being offered. Network service assurance is essential functional block, however, in a constantly changing digital environment, digital customer experience is more holistic and expects seamless interactions or engagements across the multi-digital channels for all the services and applications. For CSP, the Service Operation Center is the second level of their journey towards the digital customer experience. Service Centric Operation has major KPIs linked with

quality of service (QoS) and limited aspects of the quality of experience (QoE) of the digital services offered to self-organized customer. End to end service performance, network monitoring and proactive course correction are fundamental capabilities that CSPs must have.

5.3.3 Experience Management Level

Experience Management layer, is more specific and centric towards the Customer Experience Value for each and every customer of CSP. Here the primary focus is to monitor and manage the end to end service experience perceived by an individual customer or subscribers in constantly changing digital world. For CSP, it's desired to take all the necessary, corrective and proactive measures to maintain the enhanced customer experience across all the customer touch points for all the services being consumed by an individual customer. The Experience Operation Center (EoC) enables CSPs to take proactive measures to enhance and maintain the customer experience. Customer experience management is a top-down transformation of the enterprise to initiate the strategic initiative and break the organization silos or functions towards the customer centricity. EoC with predictive analytics functionality plays a dynamic role to identify the needs of the customer before they get to know their needs. It assists the CSP to provide proactive recommendations and carve out the customer experience journey as a trusted and valued digital service provider.

Live Video streaming or video calls irrespective of the type of applications like WhatsApp or Skype or Viber or YouTube, its most desired for CSP to maintain the quality of experience (QoE) throughout the session of engagement and consumption of services for each individual customer. Consistent quality of service is the default expectation here to offer seamless customer experience across all the digital channel. Data Analytics and Data Lake are crucial functionality here to analyze and take proactive course correction to maintain and manage the personalized customer experience across the multiple devices without any location constraints through multiple or preferred digital channels. For Examples - live events at stadiums, live football matches etc.

5.3.4 Customer Value Management Level

Customer Value Management is also named as Experience Value Management. It is an ultimate level of Digital Customer Experience management for the CSP Organization. It is centered around the Value for Organization. Business benefits which CSP can achieve by enhancing and managing the customer experience is the foremost objective of this level. CSP has established a relationship with their customers and leverage the business benefits, i.e. additional revenue through personalized & enhanced digital service experience and improving the CLTV (customer life time value - revenue from customer through out the customer life cycle). Economics, Monetization of DCEx is a significant objective of CSP through digital transformation that is to improve their Net Promoter Score (NPS = % of Promoters minus % of detractors) where customer promote their services and brand (i.e Customer Advocacy & Loyalty) Broadly, all the global CSPs are interested to establish the linkage between NPS and the business revenue generated, i.e. Average Revenue per User (ARPU) through enhanced customer advocacy, loyalty as a result of better digital customer experience. Better NPS has impact, it has potential to improve the CLTV, means more consumptions of the services lead to a Business value for the CSP.

Better NPS also assist to optimize the churn and improve the revenue as identified promoters can be used to promote services through targeted engagements. There is possibility to motivate neutral customers to promoters by proactive assisting them in increasing usage, namely data habit building. Again targeted retention actions for the dissatisfied customers through proactive engagements can be added value to CLTV for CSP.

6. Digital Value Realizations

These define the potential benefits for both Self-organized Customer and CSP as a result of enhanced customer experience through DCExT transformation. Customer Experience Value and Business Value are respective benefits for the customers and CSP respectively,and it's indicated in figure 9(b). Strong correlation between both the potential Digital Values is primarily interlinked with CSTs DCEx Maturity level. Higher is the level of DCEx maturity of CSP better will be the potential Digital Value Realization and vice versa.

6.1 Customer Experience Value

It's a value produced for the customer through the enhanced seamless, personalized customer experience across multiple digital channels offered by CSP. It includes enhanced proactive customer engagement, better digital products and seamless experience across all the customer touch points. Uniform customer data across all the channels, personalize interactive engagement and trendy & relevant digital product offerings enables customer to sense the value for money for their engagement with CSP. It is also termed as a *Value for Customer*. It begins with transaction automation and establish a long

term relationship which boost the Customer Loyalty towards the communication service providers. If CSPs take the integrated actions to provide an enhanced customer experience across the multiple digital channels through their personalized digital devices, then the customer inclined and becomes more loyal towards the organization. Customer loyalty potentially builds a long term relationship and enables the customer to go for more relevant services or products.

6.2 Business Value

It's a value for an Organization i.e CSP, it assists to monetize digital offerings as a result of enhanced customer experience through personalize engagements . By enhanced customer experience there is a high potential in the improvement of service consumption and it also enable to go for new products though proactive engagements with customers. It provides CSP to use predictive analytics to customized product offering across all the digital channels to generate the additional revenue throughout Customer journey. DCExT enables CSP to take productive steps to improve service uptake, targeted add-on personalize offerings, better churn management and counter retention offers with a lower churn rate. These are additional the revenue streams for the CSP, those were never been tapped so effectively before the digitalization. Multiple proactive measures to engage sensibly with a customer results in revenue. It is termed as a *Value for Organization*. Indicative DCEx value realization flow is as shown below in figure 9.

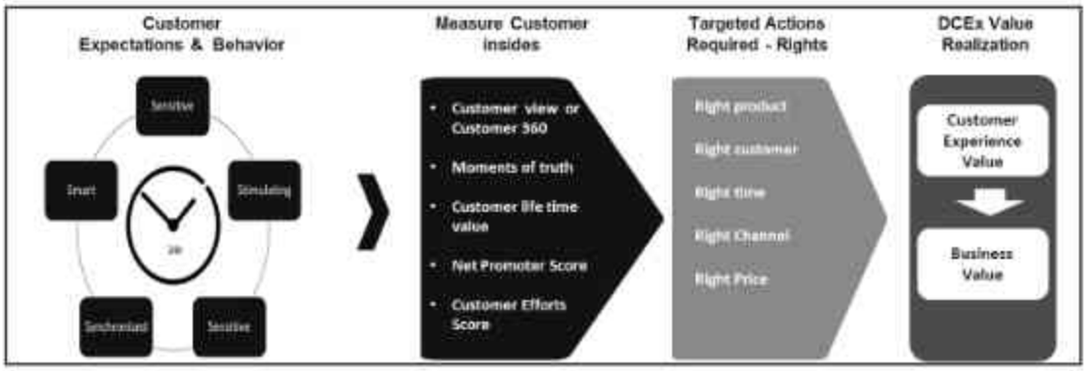


Fig. 9: DCEx Value Realization Flow for the CSP

CSP can establish a trusted, transparent relationship by countering different digital disruptions through transformation with customers. Customers begin to perceive a value for money through quality digital products. There is a high probability that a customer can be Brand Ambassador and they becomes a very strong promoter. They promote the service offerings, though their social network or word of mouth and also consume more services which lead to higher Customer lifetime value (CLTV). Customer lifetime value is revenue generated from customers throughout their service tenure with CSP. Customer efforts score is essential to measure the perception of customer about their interaction touch points. It drives CSP towards the their profitability and help to retain their neutral customers as well.

7. Dynamic Multi -Model Alignment DCExT Approach

Digital Customer Experience Transformation embraces the digital disruption as stated in this paper. However, it also needs dynamic multimodal approach to align with changing CSPs business priorities and constantly evolving customer behavior. In a disruptive digital world, there is coexistence of the distinct digital proficiency which is again adds disruption for the CSP. Single or traditional business model is inefficient, inflexible to accommodate evolving impacts of multiple digital disruptions. The CSP must have to innovate, co-develop and co-create along with their technology and business partners to adapt the changing business, operational and technical functional needs and capabilities. Even Go-to-Market need to be very targeted with relevant – digital products, solutions or offerings to suffice the disruptive experience hunger of digital customers across multiple digital channels. The Recommended Multimodal approach is highlighted in figure 10 to address the multidimensional customer experience and transform an organization to achieve the sustainable growth and profitable market share.

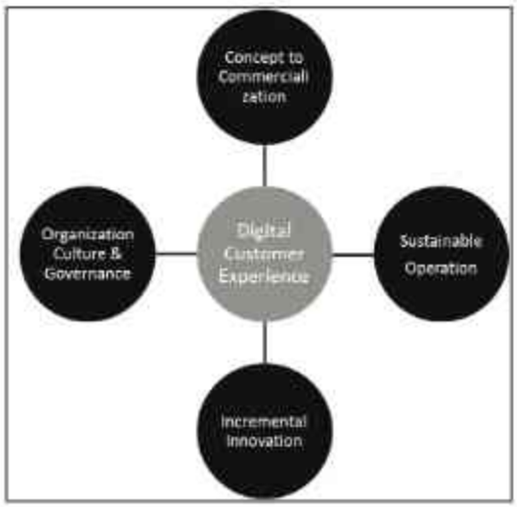


Fig. 10: Dynamic Multiple Model DCExT Approach

7.1 Concept to Commercialization

Digital Customer Experience has never be an afterthought, however, its backbone of the Communication Service Providers in order to be competitive in the Customer's Digital World. There are multiple digital technologies (Big Data, Cloud, Augmented/Virtual Reality or Analytics, Robotics) CSP has to choose the right technology, platforms and partners keeping the long term DCEx interest of the organization intact. Digital Technologies are evolving and CSPs will require continuous realignment in their business model to commercialize the concept and monetize it to its full potential.

7.2 Sustainable Operations

Streamline the internal - external way of working and communications across different business functions, leadership or management of Communication Service Providers is requisite. It assists to enhance the cross channel process automation workflows across customer touch points throughout the Customer journey. A Customer focused organization structure, resource competency, customer experience key performance indicators and tools are essentials to manage data which enable CSP to tap the next best actions towards the customers at the right time with the right context of engagement with the right product to boost customer experience.

7.3 Incremental Innovations

Digital disruption is a new normal and will exist in future as well. Constant changes in customer behavior create a new risks and also best business opportunities for CSP. Digital Native players have changed customer engagement and experience of products and services in a very profound ways. However CSP must need to rebuild and realign themselves to embrace digital disruptions with continuous incremental innovation to be relevant for digitally disrupted customers. The CSP must need to invest regularly in new capabilities -business, technical and Operation to offer new innovative products for their own survival.

7.4 Organization Culture & Governance

Constantly evolving digital disruptions enforce the need of continuous change & its management Different business functions of CSP must realign themselves with the changing environment to embrace disruptions. Organizational governance should be cross-functional, including multiple business functions collaboration and discourage the organizational silos. Customers Priority or their needs should be the top most business objective of an organization. It's kind of *Customer First Culture* across the organization is essential to embrace Customer Behavior.

8. Conclusion

Digital disruptions are a new normal in constantly evolving Customer's Digital World. Digital Customer Experience is the backbone of the Communication Service Providers in order to be relevant to their customers and market. Digital disruptions continuously transformed the customer experience and their expectations. Digital natives companies are creating new threats and eating CSP's revenue with their dynamic, innovative multi-model approach and digital products. The communication service providers must need to transform themselves to embrace the digital disruptions to enhance the customer experience and create a business value in a constantly disruptive business environment. Digital customer experience transformation is the progressive and the lone solution for CSP rather be complacent. CSPs must need to be well equipped to change in order to survive and embrace the DCExT to avoid the extermination due to disruption created by digital natives and digital disruptions.

It is challenging to manage the changing customer experience across the digital touch points and expectations without being a digital company and having digital competencies. Communications Service Providers should continue to stretch the digital boundaries of what is being offered and how is the customer engagements?

Communications service providers should be flexible and incorporate the best of digital attributes from the digital native companies, from other industries and must be ready for continuous transformation as its continuous journey for the sustained growth and not the final destination.

References

Kane, G. C., Palmer, D., Phillips, A. N., Kiron, D., & Buckley, N. (2015). *Strategy, not Technology, Drives. Digital Transformation Becoming a digitally mature enterprise.* MIT Solan Management Research and Deloitte University Press.

Singhal, P., Forst, H., McClurem, G., Sachdeva, A., Droogenbroek, B. V., Baschnonga, A., & Mahajan, S. (2015). *Global telecommunications study: Navigating the road to 2020.* EY.com. Retrieved from http://www.ey.com/DLResults?Query=Global+telecommunications+study%3A+navigating+the+road+to+2020&Search=A

Samans, R., & Davis, N. (2017). *Advancing human-centred economic progress in the fourth industrial revolution.* World Economic Forum. Retrieved from https://www.weforum.org/whitepapers/advancing-human-centred-economic-progress-in-the-fourth-industrial-revolution

Ashton, M. (2016). *The impact of digital disruption on customer experience.* CX Network. Retrieved from https://www.cxnetwork.com/cx-digital/articles/the-impact-of-digital-disruption-on-customer

Thompson, E. (2011). *The gartner customer experience management maturity model.* Gartner, Inc. G00217544

Fox, B. (2015). *Restoring connections: How telecommunications providers can reboot the customer experience.* IBM Institute for Business Value. Retrieved from https://www.cxnetwork.com/cx-experience/white-papers/how-telecommunications-providers-can-reboot-the

Cansfield, M., Hicks, A., Bonacina, L., & Owen, E. (2016). IDC insight Communty. Why Telcos Need to Embrace Digital Transformation Now. Retrieved from Idc-insights-community.com

Valdez-De-Leon, O. (2016). A digital maturity model for telecommunications service providers. *Technology Innovation Management Review.* 6(8). Retrieved from www.timreview.ca

Constellation Research. Five Generations of Digital customers and workers, not by age, but by digital proficiency. Retrieved from https://www.youtube.com/watch?v=LUJM_6-t4Q8

Westerman, G., Calméjane, C., Bonnet, D., Ferraris, P., McAfee, M. (2011). MIT Center for Digital Business and Capgemini Consulting. Digital Transformation: a Roadmap for billion –dollar organization.

Guest, M., Stonell, A., Schachtel, J., Rangel, H., & Schachtel, J. (2016). Deloitte MCS Limited. Digital transformation for telecom operators Adapting to a customer-centric, mobile-first world.

Knowledge@Wharton – Dell Digital Business Services. (2015). Customer Journey Mapping Is at the Heart of Digital Transformation. Retrieved from www.dell.com/digitalbusinessservices

Article can be accessed online at http://www.publishingindia.com

Empowering the Future 5G Networks: An AI based Approach

Anuradha C. B.*, Puneet Sharma**

**Senior Consultant, Ericsson India. Email: anuradha.c.b@ericsson.com*

***Senior Consultant, Ericsson India. Email: puneet.s.sharma@ericsson.com*

ABSTRACT

The next telecommunications standard, 5G, envisions that the future networks will support advanced use cases, such as Internet of things while supporting voluminous simultaneous connections with high bandwidth as well as low latency. Further, these 5G deployments will not be static in nature, with new use cases and service requirements evolving in future. Such requirements pose many deployment and operational challenges to MNOs. These use cases would not only require the networks to be aware of connectivity related parameters, but also adapt intelligently based on parameters beyond the network. This requires the 5G networks to be capable of addressing conditions which are not foreseen at the time of designing them. Such capability requirements can be adequately addressed by advances in the field of AI and machine learning. The objective of this paper is to explore ways to leverage AI and machine learning for enhancing the 5G network deployments and operations. This paper attempts to decipher future demands from the 5G networks analyzing specific requirements in the areas of network planning, network operations and network optimization. This paper also discusses the strategic perspective for MNOs to benefit from applications of AI in 5G networks.

Keywords: 5G, AI, Machine Learning, 5G Challenges, Operations, Network Automation

1. INTRODUCTION

5G opens up several opportunities for the MNOs. However, with increasing competition and reducing margins, there is a dire need to ensure profitability while augmenting user experience. In this context, we look into the applications of AI and Machine learning for managing 5G networks. We have looked into three key phases of managing networks – Network planning, Network operations and Network optimization.

In network planning phase, AI can be utilized for better understanding of how the network will be used in dynamic conditions, thus leading to superior investment decisions. In the network operations & optimization phase, AI enables the 5G network to behave as an intelligent entity, while learning and evolving with time, leading to significant operational savings. Thus, AI technologies help MNOs to achieve both CAPEX and OPEX savings. We also explore how these AI applications can be leveraged in strategic decision making by MNOs. In the following sections, we will discuss how traditional ways of network management can be enhanced with help of AI.

2. ARTIFICIAL INTELLIGENCE

Artificial intelligence refers to the field of study related to making machines capable of human like intelligence. AI is not a new concept and has existed for decades. However, it's only recently that the vast potential of AI technologies seem to be realizable. This change has been possible due to significant growth of data with reducing cost for sensors, devices and storage. In general AI technologies can be applied to communication networks in two ways. First is a basic application where the control entity evaluates multiple pre-set solutions to respond to a given set of environment variables. Second and more advanced level of AI entails making the control entity intelligent to be able to learn from its experiences. Thus the system will have the capability to interact with its environment. The interaction would include sensing the changes, mining the data, predicting the outcomes and reason based on its past experiences. Thus the system is able to handle unknown scenarios on its own (Aman Naimat, 2016).

For this paper we focus on the advanced level of AI technologies used for making systems adaptable and learn with experience. This is referred to as machine learning

aspect of AI. Machine learning can be further categorized into supervised, unsupervised and reinforcement learning algorithms. Supervised learning involves learning from a set of input-output pairs, and may not be applicable for problems where desired output is unknown. Unsupervised learning is used when user does not know how to classify the inputs, and the system is expected to classify the data based on its statistical nature. Reinforcement learning includes the process of learning the behavioral model by sensing in a new environment, and taking decision which follows the process of feedback (reward or punishment) from the reward definition based on the outcome behavior. Thus the model tweaks itself based on the difference from the reward definition. We discuss further how these algorithms can be utilized in 5G networks to achieve strategic objectives such as cost optimization and enhanced user experience.

3. 5G Networks

5G is a set of evolved network technologies aiming at providing ubiquitous connectivity to vast range of devices and applications (Ericsson, 2017). 5G networks do not rely on any one specific radio-access technology and entail support from a portfolio of access and connectivity solutions to address the mobile communication requirements beyond 2020.

5G will address huge traffic and bandwidth requirements while supporting wide range of connected devices and enabling real time, highly reliable communication for mission critical requirements. For supporting these requirements, the implementation and deployment of network infrastructure would undergo significant changes. This would have to be based on software-defined networking (SDN) and network functions virtualization (NFV). As per this trend network operations will become more cloud enabled, and we see an obvious opportunity for leveraging AI to achieve cost optimization with enhanced customer experience in 5G networks.

4. Addressing 5G Network Challenges with AI

According to ITU 5G standards, 5G cellular networks are key enablers to massive machine type communications, low latency services and high bandwidth consuming services. Data rates of tens of megabits per second for tens of thousands of users and several hundreds of thousands of simultaneous connections for wireless sensors are anticipated to be fulfilled by 5G. However, 5G just enables enhanced network function in pre-defined conditions. The requirements of enabling advanced configuration, dynamic networks and providing new service creates challenges for managing 5G networks. We elaborate how these challenges can be addressed through an AI framework, applying it to the 5G Cellular networks with an integrated architecture. We also showcase the use of this framework in addressing the challenges faced during network planning, operations and optimization phases.

4.1 AI based Framework

The below figure elucidates the framework for 5G network empowered with AI (J. Pérez-Romero, 2015) for network capacity planning, operations and optimization. The framework is based on input data from various sources, which is innovatively processed, to provide decisive actions to be performed on the network and to provide insights for assisting MNOs decisions through decision support systems.

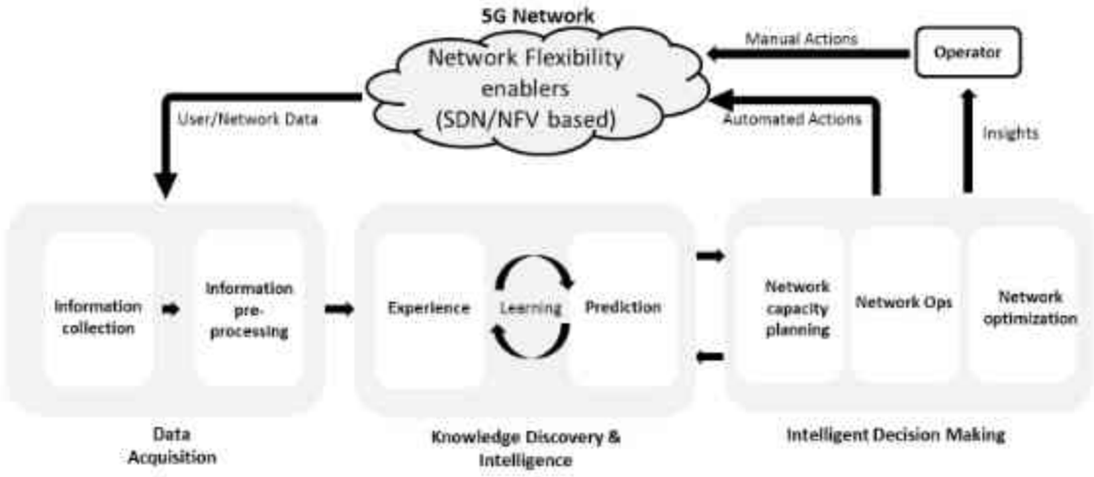


Fig. 1: AI based Framework for 5G Networks

4.1.1 Data Acquisition and Pre-processing

5G network operations and planning faces challenges in analyzing and correlating complex and disparate sets of data, which resides in multiple systems such as CRM, NMS, BSS, inventories, etc. The data could be network data, user data, content data and external data.

During data pre-processing, the information from multiple systems is prepared for mining, through below tasks:

- Data cleaning – Includes removing in-consistent and noisy data.
- Data integration – Includes combining data from multiple sources.
- Data selection – Includes selecting relevant data specific to the problem.
- Data transformation – Includes changing / consolidating the data for further mining (e.g., summarizing, aggregating etc.).

4.2 Knowledge Discovery & Intelligence

The Knowledge discovery stage uses machine learning tools, to build models which will drive network planning and operations decisions. As elaborated earlier the Machine learning techniques are usually subdivided into supervised, unsupervised and reinforcement learning. These can be used to identify algorithms & models based on input information.

Classification is the process of identifying model to describe and differentiate data sets. The identified model, called classifier is in turn used to determine the class. Further, Prediction identifies appropriate models to forecast the parameter values (e.g. the traffic requirements in a particular region can be anticipated with help of past trends and any changes in associated indicators). This is essential during network planning and is elaborated in future sections.

4.3 Intelligent Decision Making

During this stage, the extracted knowledge, for e.g. prediction of traffic, will be used to recommend or decide actions for the network. These actions can be leveraged during network planning and operations processes

4.4 Network Flexibility Enablers

SDN and NFV technologies, which enable dynamic 5G networks play an essential role in this AI based framework.

According to the Open Networking Foundation (ONF), software defined networking (SDN) is a network architecture that decouples the control and data planes, and provides a centralized view of the distributed network for more efficient orchestration and automation of network services, through a centralized application called SDN controller. This will enable the network control to become directly programmable and abstract the underlying infrastructure, for applications and network services. While NFV is a concept, which focuses on optimizing network services themselves, wherein the network functions such as DNS, Caching, etc are decoupled from proprietary hardware appliances, so they can run in software to accelerate service innovation and provisioning, particularly within service provider environments. These network programmable capabilities of SDN/NFV, key for achieving the real time needs of 5G, lay the foundation for deploying AI and Machine learning technologies. Detailed discussion on SDN/NFV is beyond the scope of this paper.

4.5 AI Enabled 5G Cellular Networks

Figure 2 illustrates a viable 5G cellular network architecture, integrated with AI framework. The AI controllers sit on the top of the network entities, which act as applications. During the data acquisition stage, these AI controllers communicate with CN, RAN or SDN controllers, through open Interfaces.

AI center obtains the cellular network data through various heterogeneous sources such as SDN controllers etc, after which the AI center will utilize its inbuilt functionality (sense, mine, predict and reason), to provide recommendations or actions for performing on networks.

The AI center will read data from disparate systems such as:

- SLA - includes data on coverage, failure duration, redundancy, etc.
- UE - includes information specific to UE - any battery limitations or the category of receiver etc.

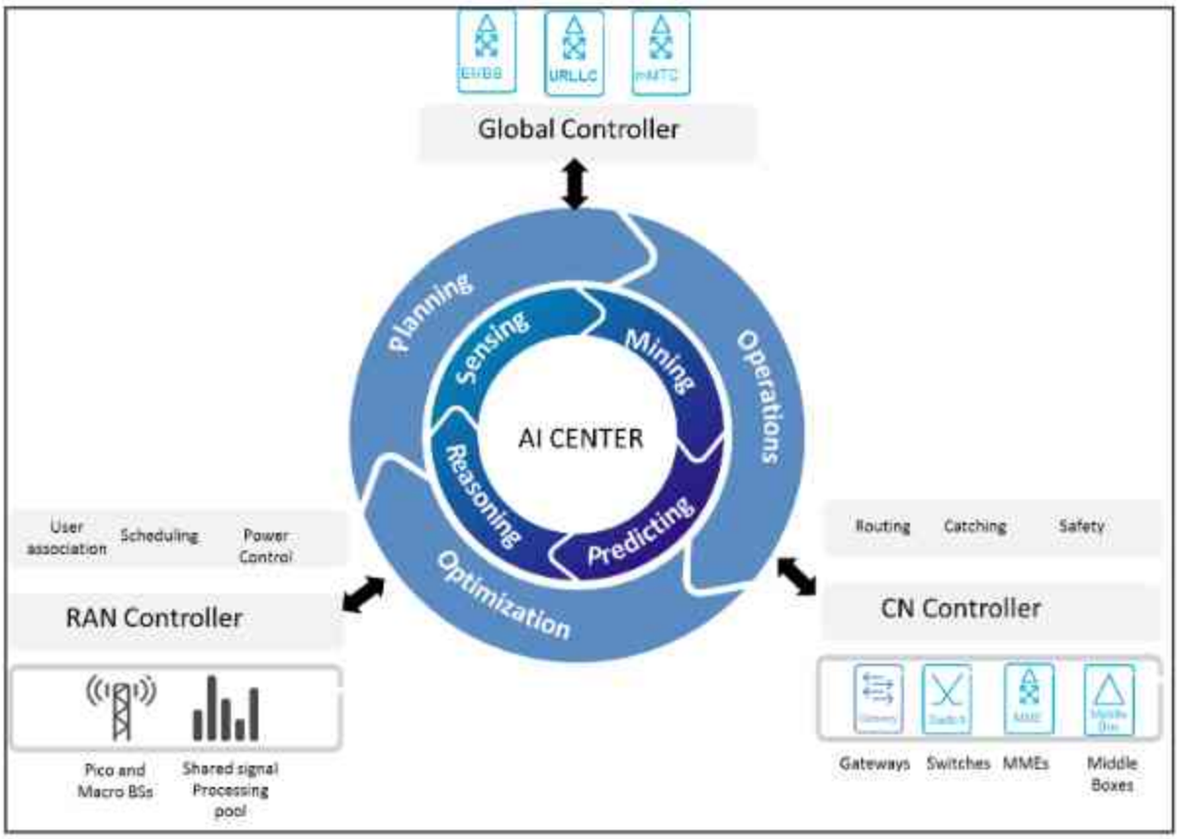


Fig. 2: 5G Architecture Enabled with AI

- Network - includes information such as #subscribers, spectrum, QoS, Network function KPIs, maintenance etc.
- Infrastructure - includes information such as CPU, memory, network standard, storage etc.

AI center will further processes the acquired data and provide recommendations on several aspects to the SDN controllers. The information includes Traffic analysis report (e.g., suggestions for the service provisioning), UE-specific data (e.g., allocation of bandwidth, priority of serving etc.) and notifications for network configuration (e.g., access methods, network alerts, and parameters for adjustment). This can be elaborated further discussing through planning, operations and optimization processes.

4.6 Network Planning

An accurate network planning is a challenging process as planning methodologies involve various parameters which are uncertain and vary in time and space. Traditionally, this has often led to overprovisioning and, consequently, excess CAPEX. The challenges are exponentially increased in 5G networks, which are fueled by the volume, variety and velocity of data (J. Pérez-Romero, 2015).

4.6.1 Traditional Network Planning

Cellular network planning involves resolving a high number of complex issues, which include: Uncertainty of input parameters, Lack of accurate network details, and complexity of network.

The figure (Mario Pickavet, 2010) elaborates on a typical network planning process, in which the fixed inputs are provided as inputs to the iterative design process. Initially, pre-design parameters are decided such as choice of technology, network architecture, etc. Subsequently, based on these initial choices, the actual network is designed.

The network node and link capacities are dimensioned based on the routing strategy, demand of the traffic and the position of the link. Generally many approximations are applied during this phase.

After the actual network design, this is evaluated in detail from cost perspective, and is simulated, if necessary, to ensure if the actual traffic is aligned to the approximated traffic demands. Based on the evaluations, the pre design decisions are revisited.

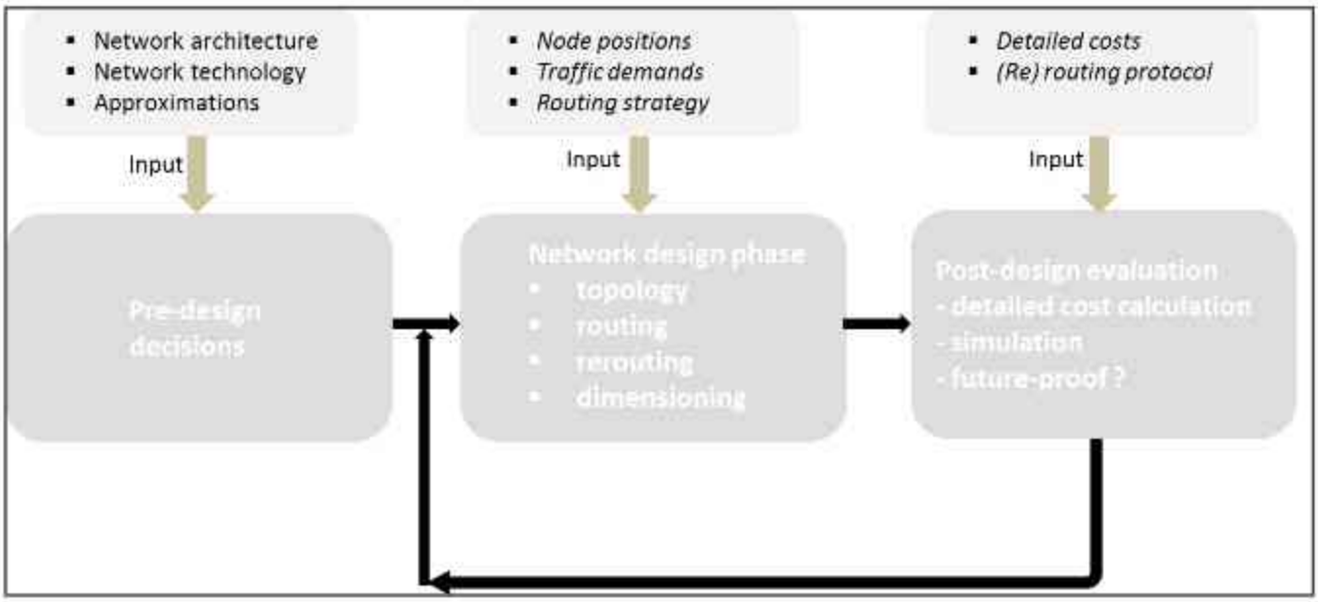


Fig. 3: Traditional Network Planning

4.6.2 Dynamic Network Planning

5G networks will be fueled by the emergence of big data analytics. Big data proposes an overwhelming amount of velocity, variety and volume, and is dynamic in nature.

Circumventing this problem, AI techniques like Simulated Annealing, Tabu Search and Genetic Algorithms can be used to solve complex network design problems.

In this process, AI center obtains the cellular network data through various sources such as SDN controllers etc, processes the acquired information and then feeds back the learning, leading to a dynamic architecture.

As highlighted earlier in this paper, the AI center includes modular capabilities to sense, mine, predict and reason the data. These AI modules are used in forecasting the traffic patterns that can be used as input for network planning with greater accuracy. For instance, the data obtained by tracking UEs location is leveraged by AI prediction module for forecasting mobility trend. Reasoning module proactively notifies UEs to update location record, to prepare handover resources and save signaling cost of mobility management.

Additionally, models can also be derived by decomposing the expected traffic demand from time, space and QoS perspectives. From the time and space perspectives, the fluctuations on the required capacity could be due to predictable conditions such as weekend and working days or unpredictable conditions such as accidents, etc. From the QoS perspective, the traffic decomposition could utilize the dimensioning from space and time perspectives, and inference can be drawn by association with user groups. Traffic characterizations can also lead in identifying the mobility patterns, to extract data about daily movements.

Further, Classification techniques can be applied up to the cell level based on the traffic category and by using the prediction techniques, capacity can be dimensioned with greater accuracy. Few situations could lead to providing inputs to decision support systems in adopting spectrum trading strategy by MNOs.

4.7 Network Operations

The critical tasks of network operations encompass configuration management, network monitoring and service provisioning.

4.8 Configuration Management

Given the complexity of 5G networks, which are expected to cater to highly scalable and diverse devices, the configuration management and maintenance is cumbersome. The configurable parameters have evolved with the telecom technology. While there are 500 configurable parameters in a typical 2G node, 1000 are required in 3G nodes and the number rises to 1500 for a 4G node. Considering this trend, a typical 5G node could have 2000 configuration parameters (Rongpeng Li, 2017). Hence it becomes imperative to address configuration management with a highly automated approach.

The self-organizing features play a critical role in enhancing the intelligence in 5G era. The self-organizing features include self-configuration, self-optimization and self-healing. Self-configuration refers to the automatic configuration of the initial parameters that encompasses neighboring cells list, IP address and the radio access parameters.

For the automatic configuration of series of parameters for rendering best services, AI techniques like Transfer Learning (TL), RL and Dynamic Programming (DP) may be used in 5G. RL is a model free learning technique that yields superior results, which iterates through to reach optimal strategy. This is also suitable in the dynamically changing radio conditions (Rongpeng Li, 2017).

Self-healing encompasses automatic fault detection, classification of the faults and initiation of corresponding actions for recovery. AI sensing techniques such as Logistic Regression (LR), etc., can be leveraged to spot the irregularities and anomalies in the network, to further restore the system.

4.9 Network Monitoring

Network monitoring could be challenging in 5G due to the dynamic nature of the cellular environment. Currently MNOs monitor the networks through alarms, which depend on static threshold setting at the cell level. As the network is dynamic, many alarms may be missed with traditional monitoring approach.

Traditional process of root cause analysis with trouble shooting guidelines also have clear limitations as they are associated with longer investigation times and increase the cost operations. Such processes can significantly impact customer satisfaction index.

With AI powered diagnostic analytics, MNOs can quickly and accurately detect network problems and resolve them, even before they occur. Algorithms like Logistic Regression (LR), Support Vector Machine (SVM), and Hidden Markov Model (HMM) could be used for network anomaly detection or events by multiple-entry data from heterogeneous sources.

4.10 Service Provisioning

One of the remarkable evolutions in 5G is the feature of dynamic provisioning. The emergence of SDN & NFV has enabled a concept called Network Slicing which facilitates dynamic provisioning. Network slicing helps in creating customized network pipes for various services, which traditionally MNOs achieved by building dedicated networks. It also ensures certain level of quality and security to each service (Ericsson, 2017).

The future services will require dynamic and automated network slicing via self-organizing property. It involves looking at various environment variables, learning uncertainties, planning appropriate actions and configuring the networks properly. AI could be utilized to learn the variation, classify the issues, forecast the future challenges and establish automated Network slicing.

We can automate service provision (latency, error rates and bandwidth) via AI techniques such as Gradient Boosting Decision Tree (GBDT) of supervised learning, and Spectral Clustering, one-class SVM of unsupervised learning.

4.11 Network Optimization

Currently, network optimization involves manual processing & analysis and is highly supported by engineering knowledge. With the advent of dynamic 5G networks, and increasing complexity of network technologies, there is compelling need for the more automated and scalable solutions.

Optimization can be provided either via open loop systems or via closed loop systems. In open loop systems, the recommendations are provided to the network engineers, who control the network configuration. In closed loop systems, the NP&O system itself optimizes the network in near real time.

The closed loop optimization could be achieved through self-optimization which includes continuous optimization of parameters such as coverage, capacity and service quality by tuning different network settings. AI algorithms (unsupervised) like Kalman and Particle filtering can be utilized for dynamic optimization of networks.

5. AI Enabling Strategic Objectives

Depending on its strategic priorities, an MNO may want to focus on one or more of profitability (efficiency), brand differentiation (customer proximity) or market share (revenue). In our view, AI and Machine learning applications for network planning, operations and optimization help augment all of these strategic agendas. We have mapped various AI applications discussed in this paper to the business KPIs which are relevant for MNOs. This should facilitate decision making process to choose the right set of AI applications aligned with their business strategy.

Table 1: Mapping AI Applications to Corporate Strategic Objectives

AI Application	*Details*	*Business KPI / Metric*	*Corporate Strategy*
Network monitoring – self healing networks	Enhanced customer experience	CEM Score	Brand leader
Dynamic Network planning	Avoid deploying excess capex, leading to less capital burden and lesser depreciation / amortization expenses	Profitability	Cost Leader
Network capacity planning based on user mobility	Anticipate/Forecast user requirements and provide the required network capability	CEM Score	Brand Leader
Service provisioning via network slicing	Provision services efficiently and automatically	Profitability	Cost Leader
New services enabled via AI	Additional revenue via new service which would not be possible without AI	Revenue	Market Share Leader

Based on above, AI should be the top agenda for MNOs who are planning to deploy 5G networks in near future. Market research indicates that top global operators have already made huge investments in AI with BT Group, Orange, NTT and Verizon leading the pack as top investors. AT&T has also launched its Domain 2.0 initiative to transform its network and infrastructure into a highly dynamic system by replacing many of its current network elements with software using NFV infrastructure and controlling these software based components using SDN protocols. The initiative is very much based on the advanced machine learning algorithms. This trend is picking up and Telecoms.com reports that around 62% of the IT teams will be using AI by 2018 (Jason Riccio, 2016).

6. Conclusion

To conclude we would like to re-iterate that future networks offer opportunities as well as pose challenges for MNOs because of complexity involved in operating a 5G network. AI offers powerful algorithms which can be leveraged to manage these networks efficiently. These algorithms not only enable operators to estimate and plan capacity accurately but also enables significant cost savings via dynamic operations and network optimization. Thus, AI helps MNOs achieve their strategic objectives and hence we see increasing investments in this area. This is precursor to a huge demand for AI and Machine learning based systems for network planning, operations and optimization, which will further be fueled by global 5G deployments.

References

Pickavet, M., Develder, C., Baert, E., & Demeester, P. (2010). *A.I. techniques for planning telecommunication networks.* Ghent University.

Pérez-Romero, J. (2015). *Artificial Intelligence-based 5g network capacity planning and operation.* IEEE.

Wang, X., Li, X., & Leung, V. C. M. (2015). *Artificial intelligence-based techniques for emerging heterogeneous network.* IEEE.

Li, R., Zhao, Z., Zhou, X., & Zhang, H. (2017). *Intelligent 5G: When cellular networks meet artificial intelligence.* IEEE.

Naimat, A. (2016). *The new artificial intelligence market.* Oreilly.

Riccio, J. (2016). *62% of telecoms using AI by 2018.* Infogix.

Ericsson. 2017. 5G systems - Enabling The Transformation Of Industry And Society.

Ericsson. (2017). NFV. Retrieved from https://www.ericsson.com/en/networks/topics/nfv

Ericsson. (2017). Network Slicing. Retrieved from https://www.ericsson.com/en/networks/topics/network-slicing

Article can be accessed online at http://www.publishingindia.com

Digital Transformation at Workplace: ICT as a Key Enabler of Smarter Buildings

Puneet Sharma

Senior Consultant, Ericsson India. Email: puneet.s.sharma@ericsson.com

ABSTRACT

The topic of smart buildings is often discussed interchangeably with sustainable buildings which have been in focus for quite some time. The key selling point for such buildings is addressing the green environment agenda as well as reducing operational costs via efficient energy usage. A significant aspect however often left out while discussing smart buildings is related to the potential benefits that businesses can accrue by leveraging the power of ICT. These benefits mainly encompass enhanced employee productivity, employee engagement and improved space utilization of building premises.

The objective of this paper is to highlight the advances in ICT which can be utilized to create smarter buildings. Although there are several benefits of smarter buildings, the paper focuses on employing ICT to create better working environment for the occupants while enhancing the space utilization. This paper explores how smart workspaces can benefit organizations and identifies the ICT architecture for smart buildings. This paper also discusses stakeholders in the context of smart building and their perspective on benefits and opportunities in this space. The paper concludes with highlighting a few case studies of smart buildings across the world. The methodology includes analyzing and proposing advanced use cases possible by integrating the enterprise IT systems with IoT/M2M sensors and building management systems.

Keywords: Smart Building, Smart Workspace, Employee Productivity, Space Utilization, Digital Transformation

1. INTRODUCTION

1.1 Need for Smart Buildings

"We shape our buildings, and afterwards our buildings shape us" - Winston Churchill

We have seen how digitization has disrupted the way businesses operate today. A thorough understanding & application of this trend has become a critical part of strategy process for any forward looking organization. While digitization brings a major shift in how business is conducted, these technologies also bring an opportunity to transform our workplace. This transformation is strategic for several reasons including enhancing employee engagement & productivity while improving the office space utilization for the building. In this paper we will study these potential benefits and relevant use cases which are possible with the advancements in ICT.

To understand why we need smart buildings, first we need to understand how the workforce has transformed over the years. Today, most employees utilize digital technology quite frequently in their daily life and expect nothing less from their workspace. For example, employees expect office meeting room reservations to be accessible and adjustable over smartphones. An increasing percentage of employees want personal control over the temperature & lighting in their seat location. Thus employees have become active participants and consumers of their workspace. Providing such flexibility not only engages the employees but also improves their productivity levels as we shall observe in next few sections.

Another significant aspect enabled in smart buildings is the improved space utilization of the office building. With precise insights on how the building spaces are being used, office managers can allocate resources efficiently and also do long term planning for the real estate leasing decisions. As we will discuss in the paper, space utilization can also be improved by automating seat allocations & hot desking solutions enabled by the data and insights gathered via an array of sensors deployed in a smart building.

1.2 Smart Buildings are More than Just Green Buildings

For a long time, buildings have been considered to be static assets which once built needed minimal

maintenance and interaction. Thus lot of focus was on the initial investments and implementation with a secondary view to how buildings will be run. This view has changed as operational costs of running buildings have increased over the long lifetime of a building (Fuller, 2016). Many governments are introducing regulation for building maintenance to ensure resident safety and efficient use of energy resources (NYC.gov, 2017). Also, a lot of environmental initiatives have increased the consciousness of green agenda, due to which real estate companies have been focusing on constructing Green buildings. The improved energy efficiency in such buildings is achieved by several steps such as: utilizing newer building materials for utilizing sunlight for heating, using screens/glass for enabling natural lighting, deploying water management systems for recycling water within the building etc. These initiatives towards Green buildings indicate a good start, however such buildings still do not fully leverage the power of ICT and have a scope of improvement in several aspects. First, as green buildings utilize basic sensor technologies, the systems are either mechanical or have a pre-defined behavior for a limited set of conditions. Thus building systems have restricted intelligence to control Heating, Ventilation, Lighting, Access and Security. Secondly, most green building systems act independently and locally. A lot more is possible in case the green building systems are integrated with a smart building management system (BMS) which enables use of data from several systems to take synchronized decisions for the building as a whole.

Thus smart buildings are not just green buildings and enable much more that energy savings. Another key reason for using smart connected buildings is surveillance & security. However, as the topics of Energy savings and Security surveillance have been widely discussed and their ROI understood and accepted, these are not discussed further in the paper and we focus on the broader set of use cases which enhance space utilization and occupant experience in an enterprise setting.

2. ICT Enablers for Smart Buildings

In recent years sensor technology has evolved significantly while device costs have plummeted. Thus sensors can be deployed to monitor everything in a building including lighting, temperature, air condition, motion, presence & number of people etc. Also, cloud computing has enabled huge amounts of sensor data to be stored and powerful analytics to be run to drive strategic insights. Further, the intelligence need not be coded, and can be learnt and enhanced with use of machine learning algorithms. This capability, when coupled with edge computing, provides very low latency on automated and intelligent decision making. It includes several scenarios such as automated light control when a meeting room is empty, managing thermostat based on occupancy level and external weather conditions etc. This enables facility managers to manage, monitor & optimize real-time building operations.

Going a step further, ICT can be used to integrate the enterprise IT systems with the BMS built on API based design and information exchange. Thus BMS would integrate all relevant information (e.g., employee data, visitor schedule, email, calendar etc.) enabling accurate decisions based on contextual information as well as personalized preferences of occupants.

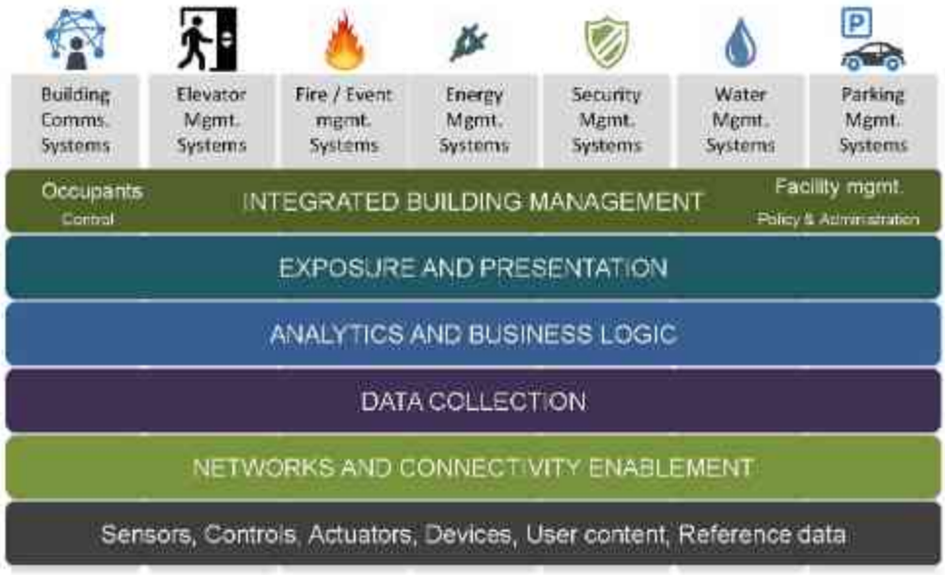


Fig. 1: ICT Framework for Smart Buildings

We can refer to the smart building ICT architecture stack presented in figure 1. As indicated, the sensors form the lowest layer in the stack and collect data, implement actions based on logic from above layers. This is followed by the Network layer which enables connectivity between different building systems as well as with enterprise systems, analytics engine and databases. Next is the data collection layer which includes databases/data centers for the smart building information that is collected over time. This is followed by analytics where business logic resides and drives the automated actions and generates insights for users. Above analytics, we have exposure and presentation layer which is used to structure information for the consumption by building occupants and facility managers. The whole stack is presented to users in the form of an integrated smart BMS, which can be used for controlling systems behavior as well as for administering any policies related to space management. Finally the BMS supports different vertical segments (such as communications, elevator, fire, water etc.) within the smart building.

3. Key Benifits

3.1 Employee Productivity

"Productivity isn't everything but in the long run it is almost everything" - Paul Krugman

Productivity in an office context signifies quantity and quality of work delivered by the employees. In most knowledge based work, a good way to understand productivity would be to measure the time, attention or amount of focus an employee can dedicate to a task. Unfortunately, these parameters are not immediately and directly measurable. Hence, we have used some indirect measures to understand the impact of smart buildings on employee productivity:

- Employee health & well-being: US labor force data indicates 3% of productivity is lost due to health reasons (US Department of Labor, 2016). A smart workspace provides a comfortable and stress free work environment to the employee. This is enabled by adequate ventilation, customized lighting and seating based on noise preferences etc. This has direct impact on employee well-being and health, leading to increased productivity.
- Employee control on workspace: A team at CMU identified eight case studies confirming the impact of providing individual temperature control on productivity gains of up to 3% (Loftness, Hartkopf, & Gurtekin, 2003). This is re-affirmed by a study from ASHRAE which indicates productivity improvements of up to 5% with configurable work environment (Fisk, 2002). In a smart building, employee productivity is enhanced by providing a configurable workspace and giving the control to employee so they can configure the workspace as per individual preferences. Thus, lesser amount of time is wasted in making and tracking helpdesk requests and employees can work at their optimal productivity levels due to improved comfort levels.
- Availability of resources to the employees: With smart BMS, employee productivity goes up as the meeting rooms are easily manageable over smart systems without need of an intermediator. Also, dynamic & intelligent seating allocation becomes highly relevant in agile and activity based projects. Employees working in same projects can be seated in proximity to facilitate collaboration and information exchange. This can evolve based on project requirements and can be updated once employees finish a project and move to separate teams on other projects.

We have discussed the positive impact a smart workplace can have on employee productivity. Considering employee costs are one of the highest components of OPEX for most organizations, productivity gains of as little as 1% via smarter workplace can translate into huge savings for the organization.

3.2 Employee Engagement

In the context of knowledge work, the cost of replacing an employee is quite considerable. It includes not only the hiring costs like job posts, interviews, negotiations etc., but also lost productivity due to inefficiency during notice periods and time & effort spent on training new employee. In many cases these costs add up to as much as two years of payroll cost for the position (Fitz-Enz, 1997). Thus it becomes paramount for an enterprise to focus on employee engagement. In the context of digitization, highly connected office environment and smart workspace have a major role in attracting and engaging employees. As we will discuss in section 4 (use cases), smart buildings provide employees with a comfortable, responsive and personalized workspace, thus enabling significant improvements in employee satisfaction and engagement. With smarter workspace, an organization can not only retain existing talent, but also promote its corporate brand value to double the likelihood of attracting new talent from market (Barklund, 2015).

3.3 Space Utilization

Smart buildings provide an array of data points which can be utilized by facility management to derive strategic insights. These can help in understanding how the space is being utilized, when is it not utilized, and ways to predict the space requirements into the future based on past trends and evolving enterprise data. Also, this analysis can be carried out dynamically with the real-time information from the smart building sensors and management system. Some of the examples where smart buildings enable higher space utilization are as follows:

- With constant monitoring of use of meeting rooms, facility managers can understand whether the meeting room is left un-booked frequently because it's not preferred by employees. The preference may be because of size, lighting etc. parameters which can be addressed to enhance utilization of the meeting room in future.
- In case the use of workspaces fluctuates heavily from low to high depending on days of week or season etc, the smart building data can be used to create forecast models so that facility managers can take informed decisions to either sub-let or sub-lease additional capacity as forecasted into the future.
- It's possible that for a particular organizational unit, the space utilization is observed to be constantly low (reasons may be due to high percentage of travelling, onsite or work-from-home employees etc.). In such cases long term decisions can be taken to reduce the footprint and lease smaller amount of space in future.

A study conducted by CBRE indicates that at least 30% of the space lies underutilized for different enterprises in APAC. For companies in the Consulting/Business services sector, the number is as high as 65% (CBRE, 2015). Smart buildings can enable facility managers to develop a better workplace strategy & planning so that a lot of this unutilized space can be released to save operational costs.

3.4 Benefits Illustration in Indian Context

Assumptions	*#*	*Units*
Employees	500	Headcount
Avg salary	700000	INR
Space requirement (Dhanalakshmi & Selvabaskar, 2014)	150	sqft / employee
Leasing cost (Construction World, 2017)	65	INR / sqft / month
Electricity usage (CDP. 2015)	2686	kwh / yr / emp
Electricity charges (Govt of India, 2017)	5	INR / unit(kwh)

Expense Calculation	*"Annual Expense (Cr. INR)"*	*Smart Building Impact*	*"Annual Savings (Cr. INR)"*
Salary	35	Productivity Enhancement	0.70
Office Leasing	5.85	Better Space Utilization	0.29
Energy	0.67	Energy Savings	0.17

An illustration is provided for an assumed office space of Technology company in the city of Pune. The efficiency is assumed based on references from previous sections. It indicates the possible benefits of converting the office into a smart building and also establishes that savings due to productivity & space utilization is significantly higher than just energy savings.

3.5 Benefits Summary

Below table summarizes the key benefits discussed in this section and maps them to performance metrics and corresponding operational savings for the enterprise.

Table 1: Key Metrics to Measure the Benefits of Smart Buildings

Benefit Category	*Impact of Smart building*	*Key Metrics*	*Operational Savings*
Employee productivity	Positively impacting employee health & well-being	# days (or hours) of absence due to health issues	Reduce operational costs in terms of employee time as well as medical/ insurance costs
	Enhance employee control on workspace	# Helpdesk Complaints related to temperature, lighting etc	Higher efficiency, meeting of timelines/deadlines
	Efficient resource availability to the employees	Reduced occupant requests via 'Help Desk' and other similar feedback systems	Reduced costs due to lesser overheads on intermediaries
Employee Engagement	Enhance employee loyalty	Attrition rates	Lower re-training costs
	Attract new employees	Percentage of employees joining who were made joining offer	Lower hiring costs
Space Utilization	Better utilize the space available with enterprise	# Complaints of non-availability of space / meeting rooms	Reduce costs spent in managing space
	Reduce space footprint in long run based on average utilization	Reduction in amount of space required per employee	Reduce real estate costs in long term

4. ICT Enabled use Cases in a Smart Building

Fig 2. Smart building use cases

The figure shows several use cases which can be implemented within a smart connected building. These use cases are explained and mapped to the benefits for the organization as follows:

Table 2: Smart Building Use Cases Description and Benefits Mapping

#	*Use Case Description*	*Benefits*
1	Automated building Entry / Exit for authorized users (car plate recognition) and automated space access by detecting identity badge proximity	Employee productivity
2	Automated car parking allotment & parking space management (lease additional parking slots or release slots to other organizations within the building)	Employee productivity Space utilization
3	Preventive maintenance of building resources: lift / common areas etc., to minimize down time. Also anticipate traffic and position the lifts accordingly.	Employee productivity
4	Hot desking: Dynamic seat allocation for collaborative work environment	Employee productivity Space utilization
5	Local environment settings as per employee preference, recommended guidelines and external weather (heating, lighting, ventilation etc.)	Employee productivity Employee engagement
6	Integrate email, calendar with meeting room booking system to enable automated booking management - suggest options based on number of attendees, location and earlier preferences of the meeting organizer. Thus employees do not book oversized rooms and also avoid the hassle of going through room choice manually. Booking is also released automatically in case meeting is cancelled / re-scheduled.	Employee productivity Employee engagement Space utilization
7	Digital signage - Use for stand up Agile meetings / discussion rather than booking out a room.	Employee productivity Space utilization
8	Pre-enrolled visitors for ease of access without wasting employee time.	Employee productivity
9	Connected facilities for replenishing consumables to avoid "out of service" and downtime for machines such as – Coffee machines, Printers, Tissue dispensers, Soap dispensers, Bins.	Employee productivity Employee engagement
10	Users can request workplace services via their smartphones, report faults via use of QR codes in different parts of the building via smartphone app	Employee productivity
11	Monitor movement, posture etc., and make recommendations - If employee is sitting for long hours, recommend a walk / break.	Employee productivity Employee engagement
12	Tracking space usage on weekly and monthly basis to forecast the requirements and decide the amount of space to be leased in future.	Space utilization

5. Key Stakeholders

5.1 Enterprises

As discussed in section-3, smart buildings not only accrue commercial benefits, but also enable higher employee satisfaction and corporate image. Stakeholders from different units within an organization can view the benefits in their perspective as highlighted in the figure below.

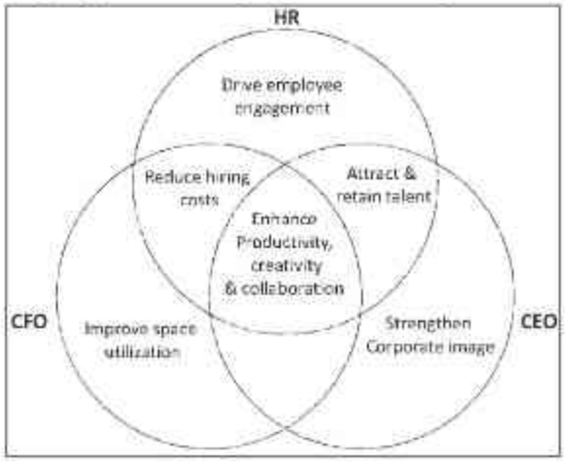


Fig. 3: Enterprise Stakeholder Perspectives on Smart Building Benefits

Enterprise IT department led by the CIO is another key stakeholder which enables these benefits for the rest of the organization. It must be understood that the true potential of smart buildings can only be realized when the enterprise IT systems are integrated with the BMS. For this, all smart building related decisions have to be either led by or developed in close collaboration with IT.

5.2 ICT Companies

ICT companies play the most important role in the smart building value chain as they are involved from the inception phase (Consulting) to delivery of smart building systems (ICT planning & design, Sensors & network deployments, Data center, Analytics and Customized application development) and continue into the operational support phase throughout the life of the building (by setting up and managing operations center for remote monitoring).

As the field of smart buildings is nascent, there are several consulting opportunities where organizations want to understand the applications of ICT to transform their offices into smarter workplace. While the subject of smart buildings falls underneath the umbrella of IOT, it needs

dedicated experts who can guide enterprises and facility managers through this transformation. A survey done by CABA indicates that most decision makers do not yet understand how to leverage the power of ICT, big data & analytics for their buildings (CABA, 2015). Thus role of Entrepreneurs & Consultants becomes critical in this space.

6. Case Studies

There are many cases of upcoming buildings with integrated, advanced and smarter ICT systems. Many of these initiatives have observed positive ROI within a short span of time. We have listed below a few case studies indicating some of the smartest buildings across the world:

THE EDGE, AMSTERDAM

The Edge is located in Amsterdam and occupied by Deloitte (Randall, 2015). It hosts a total of 2500 occupants. This building is considered one of the smartest workspaces in the world. It is specifically designed to with a consideration for agile work culture to promote employee collaboration. The building is packed with around 28,000 sensors and offers wide array of smart services ranging from automatic parking access, electric-vehicle docks, to user preference analytics. Lights are powered via Ethernet LAN transforming each lighting point into a internet connected data hub. Numerous employee friendly features make this building the model for future workplaces.

COLLIERS R&D, FRANCE

Colliers is an international real estate company and uses its R&D center in France to implement and experiment with new smart building concepts (Abdelnour-Nocera, Oussena, & Burns, 2015). With smart technologies, it has been able to achieve significant space utilization with 180 employees using just 140 workstations. It also integrated the employee IDs with building sensor network and enterprise systems to derive insights on space usage, and future workspace enhancements.

LE HIVE, PARIS

Le Hive is located in Paris and is occupied by Schneider Electric hosting 1800 employees (BREEAM, 2014). Considered one of the greenest and smartest buildings, Le hive offers a wide array of smart features to its occupants. Employees have full control over their workspace conditions like light, temperature etc., and can make changes via a smartphone app. The app has several smart features because of its integration with building management and enterprise IT systems. Employees are able to view room availability, book meeting rooms and find way through the building very conveniently. The building is also fitted with smart lighting and blinds controls. These smart features have complemented the green features to enable huge energy savings of 47% for the company.

7. Conclusion

As highlighted in the paper, it's pertinent that organizations understand that smart buildings have a lot more to offer than just energy efficiency. Also, to achieve maximum potential of its resources, an organization need to ensure that workspace is people centered, activity based and designed for flexibility with use of appropriate technology. With these aspects covered, enterprises can seek to attain higher employee productivity & engagement while ensuring better space utilization of their real estate.

Organizations which have not yet planned for this trend must understand that smart features will soon be must-have requirements for the building occupants (more so with increasing number of millennials in the workforce). It's no longer a question whether to embrace and invest in smart buildings or not. The question is whether your organization would be ready when smart buildings become essential for long term corporate success.

Glossary

ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers

BMS – Building management system(s)

BREEAM - Building Research Establishment Environmental Assessment Method

CABA - Continental Automated Buildings Association

CBRE - CB Richard Ellis, an American commercial real estate company

CMU - Carnegie Mellon University

IOT – Internet of Things

M2M – Machine to Machine

QR - Quick Response Code

REFERENCES

Abdelnour-Nocera, J., Oussena, S., & Burns, C. (2015). *Human work interaction design*, pp. 72-75. Springer.

Barklund, K. (2015). Smart Workplaces for increased Attractiveness and Performance. Coor Service management. Retrieved from http://procom.fi/wp-content/uploads/2015/03/Kati-Barklund_Smart-Workplaces_T%C3%B6rm%C3%A4ys_070416.pdf

BREEAM. (2014). Le Hive, Paris. Retrieved from http://www.breeam.com/index.jsp?id=583

All icons sourced from http://www.freeiconspng.com

CBRE. (2015). Space utilization: The next frontier. Retrieved from https://www.cbre.com/research-and-reports/apac-space-utilisation-the-next-frontier

Construction World. (2017). IT Office absorption increases by 10%. Retrieved from http://www.constructionworld.in/News/IT-office-absorption-increases-by-10-x00025-lease-transactions-up-by-52-x00025-/108165

CABA. (2015). Intelligent Buildings: The Past and the Future. Retrieved from https://www.caba.org/documents/Presentations/2015-04.pdf

CDP. (2015). Energy Efficiency Bears Fruits For India Inc. Retrieved from https://www.gita.org.in/Attachments/Reports/CDP-India-Energy-Efficiency-Report-2015.pdf

Dhanalakshmi, B., & Selvabaskar, S. (2014). Demand analysis and office space capacity utilization of corporates in Chennai. *International Journal of Enhanced Research in Management & Computer Applications, 3*(5), 30-36. Retrieved from http://www.erpublications.com/uploaded_files/download/download_27_05_2014_16_58_20.pdf

Fuller, S. (2016). Life-Cycle Cost Analysis (LCCA). National Institute of Standards and Technology. Retrieved from https://www.wbdg.org/resources/life-cycle-cost-analysis-lcca

Fisk, W. J. (2002). How IEQ Affects Health, Productivity. American Society of Heating, Refrigerating and Air-Conditioning Engineers. Retrieved from http://doas.psu.edu/fisk.pdf

Fitz-Enz, J. (1997). Its Costly to Lose Good Employees. Workforce.com. Retrieved from http://www.workforce.com/1997/08/01/its-costly-to-lose-good-employees/

Govt of India. (2017). State-wise average rate of electricity for domestic and industrial consumers. Retrieved from https://data.gov.in/catalog/state-wise-average-rate-electricity-domestic-and-industrial-consumers

Loftness, V., Hartkopf, V., & Gurtekin, B. (2003). Linking Energy to Health and Productivity in the Built Environment. Carnegie Mellon. Retrieved from http://www.usgbc.org/Docs/Archive/MediaArchive/207_Loftness_PA876.pdf

NYC.gov. (2017). Greener, Greater Buildings Plan. Retrieved from http://www.nyc.gov/html/gbee/html/plan/plan.shtml

Randall, T. (2015). The Smartest Building in the World. Bloomberg. Retrieved from https://www.bloomberg.com/features/2015-the-edge-the-worlds-greenest-building/

US department of labor. (2016). Labor Force Statistics. Retrieved from https://www.bls.gov/cps/cpsaat47.htm#cps_eeann_abs_ft_occu_ind.f.1

Article can be accessed online at http://www.publishingindia.com

Blockchain in Telecom Sector- An Analysis of Potential Use Cases

Rahul Darmwal

Senior Consultant, Ericsson India. Email: Rahul.darmwal@ericsson.com

ABSTRACT

Furious customers disputing bills, issues of payments between operators for roaming services, sim clones and illegal eavesdropping, troubleshooting in multi-vendor – These are some of the most well-known issues faced by Telecom Operator. What if there was a way to overcome these issues. The potential benefits would be huge and at same time greatly improve perception of Operator in eyes of its customers. One such disruptive technology, Blockchains, which uses Distributed Ledgers and operates trustless, is being envisioned to solve such problems within Telco's.

A lot of literature is available describing how blockchain can be used to power todays Telecom use cases, however, hardly any papers describe the challenges that needs to be overcome to actually make blockchain a mainstream technology in Telecom sector. This lack of reality check was inspiration for writing this paper. In this paper, we try to understand "Blockchains", some proposed blockchain implementation for Telecom use cases and challenges that need to be addressed to enable these use cases.

Keywords: Block Chain, Telecom, Operator, Use Case, Distributed Ledger, Bitcoins, Challenges

1. INTRODUCTION

In recent years, Telecom systems have gone through a revolution. From call and sms days of 2G, we now have always on IP network which provides blazing fast upload/ download speeds and enable all forms of communication (voice, text, video, email, etc.) through data pipes and applications installed on smart phones. However, the core technology and processes fundamentally remain the same. This means that in spite of great technological achievements, we still face same key issues (customer complaints, sim cloning, charging complaints etc.) today, that we have been facing since long time.

Blockchain is being positioned as a disruptive technology (4), (10) that is expected to completely change the way systems interact with each other. It will make transactions cheaper, transparent, secure and enable efficient use of time and resources. By using Distributed Ledgers and Trustless processes, we could solve a number of fundamental problems in Telecom sector.

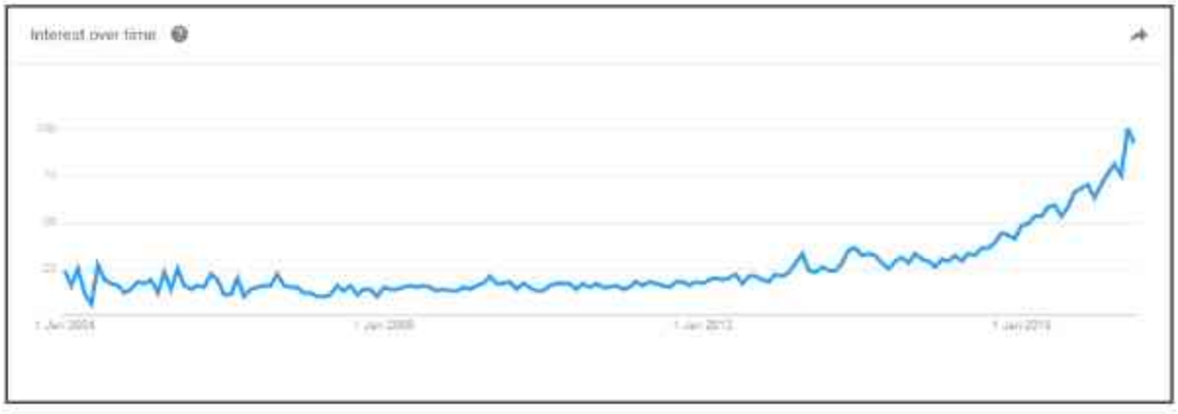


Fig. 1: Interest in "Blockchain" Over Time. 100 Indicate Peak Popularity for Search String

Source: Google Trends website

Fig. 2: Market Price of Bitcoins Since Inception

Source: "blockchain.info"

Interest in block chains has peaked in last few years based on success of Bitcoin (12), a cryptocurrency currency which is not controlled by central authorities like banks, states, government etc. Due to success of Bitcoins, financial institutes have already announced major initiatives to explore this area and we see similar interest from other domains.

We are already seeing a lot of interest on how block chains can help improve Telecom operations and its impact on existing products and services. Available literature was used to identify key use cases that will form part of this analysis in addition to some new use cases proposed by author.

2. What is Block chain?

Wikipedia (13) explains block chain as:

A block chain – originally block chain – is a distributed database that is used to maintain a continuously growing list of records, called blocks. Each block contains a timestamp and a link to a previous block. A block chain is typically managed by a peer-to-peer network collectively adhering to a protocol for validating new blocks.

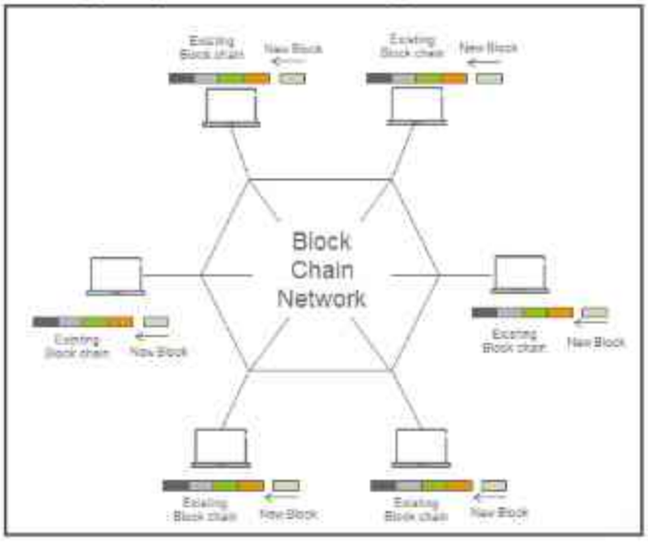


Fig. 3: Concept Drawing Showing New Block Getting Added to Distributed Ledger

So, Block chain is just a chain of data blocks, with linkages to previous blocks. And data blocks are shared with all participants on the network.

People familiar with ways of storing data will point out that this is fundamental shift in way data is stored. It is due to this change in storage strategy; block chains are revolutionizing existing use cases across industries.

To better understand how this is done, let's look at how block chain system will add new block of data. Assume that block chain has data in till Block 10.

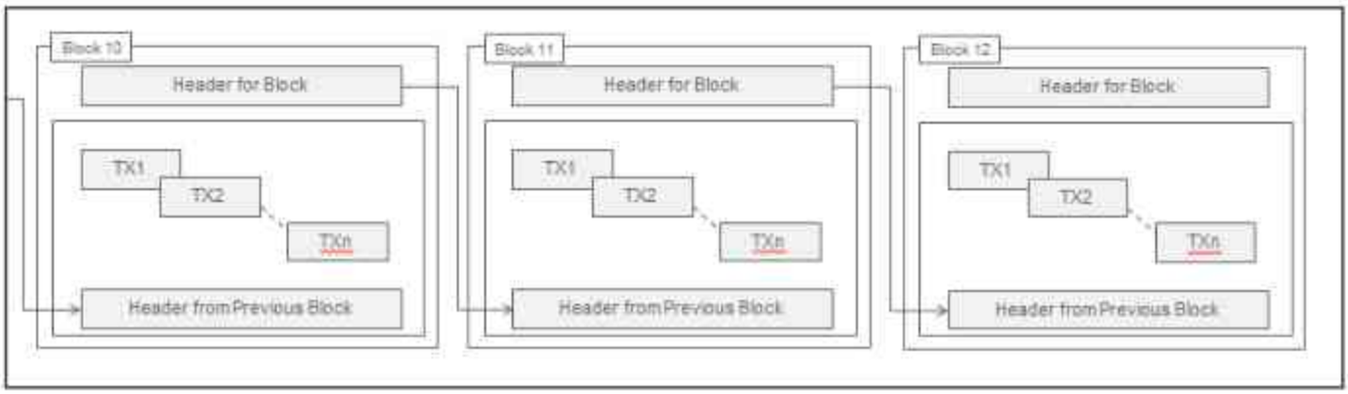


Fig. 4: Concept Drawing Showing Linkages Between Blocks in Blockchain

1. New transactions need to be added to existing block-chain. For this, Block 11 is being created by participant and this will get added to chain.
2. The various transactions are ordered sequentially in the block.
3. Header from previous block (Block 10) is added to current block (Block 11).
4. Using encryption algorithms, a header is created for new block (Block 11). The encryption algorithm considered transaction data in block along with Header from previous block (Block10). The headers are generally created using hashing algorithms, which are commonly used in cryptography. The block is then signed using participant's digital key.
5. The newly created block is now broadcasted to all participants of block chain.
6. The participants verify the block using headers included into blocks and digital signature of participants. The header contains link to previous block. The header is decoded to verify this linkage. The digital signature of sender is also verified electronically. If all checks are cleared, the participant adds the block to its chain. As, this is being done by all participants of block chain, it is almost impossible to get fraudulent transaction into the block chain without raising suspicion amongst the participants.

This linkage between current block and previous block makes each block permanent and irreversible as blocks cannot be changed without impacting previous blocks. Additionally, as data is distributed across multiple participants, it is impossible for single participant to change contents of blocks as everyone has copies thus making records permanent and non-editable.

Additionally, block chains can also be used to execute smart contracts. These are small if-then codes that run on block chains. Based on transactions taking place, the smart contracts get executed and results can impact participants of contract, e.g. if delivery receipt of order is received on block chain, release payment through block chain transaction.

Using above example, we can easily understand characteristics of block chains as explained by Deloitte (6):

1. Distributed Ledger: Transactions in block chain are stored on ledger that is available with all participants of block chain. What this means is that all participants in block chain have whole ledger (information about each and every transactions taking place between participants) and not just parts related to its own transaction.
2. Digital: Block chains are digital in nature with no linkages with physical assets in real world. This made its use in digital currencies (like Bitcoins) possible.
3. Updated near real time: Being digital in nature, transactions and updating ledger can be done in near real time.
4. Chronological and timestamped: Due to unique nature of block chains, it is possible to identify the exact time of each transaction. Even storing of transaction is done chronologically.
5. Cryptographically sealed: Each block is encoded with specific headers from previous block to create chain. This linkage means data in block cannot be changed without modifying whole chain.
6. Irreversible and auditable: Each block is created as permeant record. Once finalized, it is impossible to

modify content of block. This also makes auditing very simple.

7. Operates trustless: There is no central authority to monitor and approve transactions. Transactions are authenticated by solving complex mathematical puzzles (proof of work), based on stake in transaction (proof of stake) and other such proofs that need to be shared by transacting parties.
8. Fewer third parties: Distributed ledger and ability to operate trustless enables block chain based implementation to completely eliminate need of 3rd party mediators and trusted service providers.

Fig. 5: Block Chain Characteristics by Deloitte

3. Block Chain Use Cases For Telecom

Block chains have already made their mark in Finance industry. Success of cryptocurrencies has helped test this concept and blockchains are now being proposed for almost every data centric use case across industries. However, Finance Industry is much ahead in testing block chains use cases and it is doing so by setting up collaborative endeavors across eco-system. Some prominent ones are: (1) R3 - Alliance of world's largest finance institutes with mission to realize the benefits of distributed ledger. Some examples include Barclays, Credit Suisse, RBS, Bank of America, etc. (2) Bank-Chain, India's first Block chain exploration consortium for banks led by SBI, (3) Digital Trade Chain (DTC): built on the back of a prototype designed by the Belgian bank KBC.

Telecom industry has very recently started exploring Block chain. Initial view of leaders in this area predicts block chains will revolutionize the way Telecom Industry works. Described below are some proposed Telco use cases which can benefit from Blockchains. These have either been collected from available literature or have been proposed by author based on his experience of Telecom Operators. Besides talking of benefits, key challenges that need to be overcome have also been highlighted to explain the complexity for development and adoption of use cases.

3.1 Postpaid Subscriber Billing

All Telecom operators' charge customers for calls/sms that they make or received. Data usage is also charged by Operators and bills generated for subscribers to pay for usage. Charging mechanism works in following way for postpaid subscriber:

- Subscriber make/receive call using his device.
- Network elements create call data records (called number, duration, location etc.).
- Call data records are sent to Billing system.
- Billing system analyses call data record and performs rating functions to determine exact charge.
- Charges are tagged against subscriber and bill generated at end of month.

As is evident, the main activity here is analyzing data streams of CDR's and tagging them against subscriber. Due to huge volume of CDR's, this is done using advance data base and functions.

Using block chains, charging mechanism can be implemented as follows (9,10):

- Subscriber makes call using his device.
- Network elements capture call data records.
- Call data records are sent to billing system through block chains.
- Billing system decrypts records and analyses them.
- For rating, smart contracts can be used.
- To generate monthly bill, bill generation application reads block chain and captures transactions against subscriber. The transactions are collated and monthly bill generated.

Benefits of Using Block Chain:

1. As transactions are stored on block chains, there is no need to buy expensive database licenses. Block chains replace existing database and provides simple and open method to store call data and other records.

2. Block chain storage provide higher level of data security and integrity as no single internal system will be in-charge of storing call data records(distributed ledger). Call records would be available with all participants in block chain (e.g. network elements, billing systems, archiving systems, etc.).
3. Smart contracts will make it simple and modular to create and modify rating plans.

Challenges that Need to be Addressed to Enable this Use Case:

1. Block chains deal with blocks of data, or multiple transactions in single block. Some time and effort are spent in encrypting the block using hashing algorithms. This means, there is inherent processing time taken by system to process a block. For postpaid billing, some delay is acceptable, but for pre-paid, system needs to be near real time which will make use of block chains challenging for prepaid market. This will limit scope of this technology for charging purposes.
2. Due to huge volumes of call traffic within operator's network, block chain file will continuously get appended by new blocks, resulting in file size reaching epic proportions. Larger the file, more difficult will it be to scan the file to calculate subscriber balance, etc. (as whole block chain is scanned to identify transactions of particular subscriber).
3. A very large number of smart contracts will need to be defined to handle charging logic deployed in operators. Additionally, depending upon complexity of charging logic, complexity of smart contracts will also vary.
4. There could be need to re-rate particular call data records and correct bills due to technical issues or human errors. This re-rating would be very difficult in system that diligently follows block chain logic (as block once written cannot be edited).

3.2 Interconnect Billing

Interconnect billings deals with settlement between Home Operator and Roaming network operators, where, customers of home network uses services provided by roaming network. Interconnect billing process is done for postpaid subscribers only, as prepaid subscribers still use home network for charging.

When home subscribers go roaming and makes phone call or uses data, CDR's are generated in roaming network. These CDR's are sent to the clearing house which is like a central agency connected to various operators. Clearing house helps connect operators by providing common place to share roaming records and help to settle their interconnect bills. In current system, it is responsibility of clearing houses to process CDR's and sends correct bills to Home network. Unfortunately, due to involvement of intermediator (i.e. clearing house), individual networks do not have visibility in the settlement process which may lead to disputes.

Proposed Improvements using Block Chain (6,9,10):

It has been proposed that concept of clearing house can be eliminated completely by using block chain technology. This can be done as follows:

A private block chain for partner Telecom network operators is created. Partner Network operators are authenticated and then allowed to join the block chain network to maintain security, authenticity and data integrity. The operators can now share roaming cdr's on block chain in near real time. Because the cdr's are shared with every host on network, the home operator receives copy of cdr generated in roaming network. As Home network receives CDR's in near real time, billing can be done immediately without need of third party (clearing House). Additionally, smart contracts can be implemented to develop automation in settlement process.

This eliminates need for clearing house, thus saving costs to Telco's. Block chain implementation are also expected to improve speed and efficiency of this operation.

Benefits of using Block chain:

1. Block chains allows for transparency in inter-network billing as CDR information is saved as distributed ledger and is available with every network operator. There will be no need to send CDR's to clearing house due to use of Distributed Leader. Operators can save fees paid to clearing house for their services.
2. Distributed Leaders will make this process transparent to all parties and enable near real time billing.

Challenges that need to be addressed to enable this use case:

1. There will be need for Operators to create implementation strategy and develop the closed block chain network required for this purpose. Details could in-

clude how network is funded/created/managed, what will be process for operators to join, how settlement will take place, etc. To enable wide usage, this would need to be developed into standards.

2. The responsibility of data reconciliation and settlement will rest on Network operators and accuracy of block chain.
3. Without trusted third party to intervene, Telecom Operators would have to manage relations with huge number of operators.
4. Data privacy concerns will need to be addressed as cdr's from all partner networks will be accessible to all networks.

3.3 Using Public-Private Keys for Customer Authentication

The Telecom network authenticates subscribers using information stored on SIM card and through A3 & A8 algorithms. It follows challenge response concept for authentication. The process consists of challenge sent by network towards handset which has requested to be authenticated. The handset uses data on SIM and authentication algorithms to determine the right response and sends it back to the Network Element. The response received by network element is compared with calculated response determined by Network elements and if response matches, handset is allowed to access network.

To be able to achieve this, subscriber specific information is coded on SIM card. Same information is also stored on Network elements and it is imperative that both these set of information matches. During challenge and response, this subscriber related information is used to calculate, respond and verify authenticity of subscriber.

Proposed solution using block chains(10):

Within block chains, individuals are identified using their public and private keys. Public and private keys have been used successfully for doing transactions on internet. Similar concept can be deployed for authenticating subscribers on Telecom network. Subscriber will be the only person who will have access to his private key. Public key will be used for authentication and requesting services from network. As private keys are not shared with network at any point in customer life cycle, this method of authentication is a lot more safer than existing SIM based methods as subscriber specific parameters are stored on Network element and sim card and can be compromised easily.

Benefits of using Block chain:

1. Public private key is de-facto standard used on Internet for authentication. If used in Telecom networks, this will improve security many folds.
2. Private keys are not stored on Network elements, thus reducing risk of cloning and fraudulent usage of services.

Challenges that need to be addressed:

1. To be able to use Public-Private key authentication, there will be need to redesign authentication process for telecom infrastructure. This will be a major change for everyone in the eco-system requiring collaboration at massive scale and development of new standards
2. This will also have to be globally accepted and implemented as standard to enable concepts such as roaming, inter-operability etc.

3.4 Integrated O&M

Elements of mobile network elements are connected to their respective network monitoring platforms. These platforms interface with network elements and send commands for configuration, collect alerts, logs, and generate statistics. As the alerts/logs are coded in vendors own proprietary interface, they can be understood by their corresponding platforms only. The platforms for various network elements are then connected to central O&M elements such as those present in Network Operations Center(NOC). The central elements then translate individual messages to common language and store them in their database. These are then processed and analyzed to get Network level view of what is happening in network.

Proposed Solution with Blockchain:

It is proposed that, the network elements can form part of trusted private block chain network. Events triggered on one element can be broadcasted, using block chains to all elements on network. As all network elements are able to receive information about each other, there can be greater degree of understanding on what is happening within network. For e.g., incase an element is made operationally disabled for maintenance, the NMC's of those element can broadcast alerts to all network elements in block chain. This will help in quicker diagnosis (other elements know there has been operational activity and that they can ignore the alarms generated), add transparency by creating

non-destructible record for future auditing and improve collaboration amongst various network elements.

Similarly, configuration changes can be broadcasted to partner elements, thus enabling communication link between various network elements. Smart contracts can also be created to automate task based on specific triggers.

Benefits of using Block chain:

1. Individual Network Elements are not aware of what is happening to other elements of network. Only operators in NOC are able to get full picture and take required decisions. And even NOC operations are susceptible to translation errors, data loss and such other issues which will reduce effectiveness of their analysis. This can be avoided using proposed approach.
2. Distributed Leaders for Network elements will help create sequential, non-destructible and non-refutable log of events available across all network elements. These logs can be used to make informed decisions and execute smart contracts to automate tasks.
3. Sequential logs will create transparency between elements, which generally could be from different vendors. Transparency will improve RCA and help operators manage their network better.
4. Information shared directly between various network elements will enable an whole new way of performing O&M for network elements

Challenges that need to be addressed:

1. This will impact Network elements and the way they are monitored and managed. Standards will need to be defined and agreed for block chain implementation to enable inter-operability across network elements and vendors.
2. Such implementations will directly impact vendors of central monitoring systems used in NOC's etc. Many a times these are same as those providing network equipment leading to conflicts on what is right approach

3.5 Customer Purchase Management

Currently, purchases made by customers are tagged in CRM or similar tools. The customer does not have record of his active services and is dependent on database of operator to tell him about his active services. This leads to frequent mismatch complaints and results in time and effort spent to audit records and take corrective actions.

Proposed solution(2): It is possible to create private block chain group in which subscriber and operator are members. Any transaction initiated by customer (e.g. purchase of plan) is stored in block chain which is accessible to Subscriber and Operator. Similarly, any transaction initiated by Operator (e.g. bonus plan) will be stored in Block Chain available with subscriber and network operator. As subscriber and operator have copy of same distributed ledger, there is no scope for ambiguity between operators record and customers view (which he can see using software tool).

Benefits of using Block chain:

1. Distributed leader between Operator and subscriber will drastically reduce complaints of service mismatch(what is ordered by customer and what has been activated on Operators systems)
2. Such an initiative, if explained and marketed properly, can drastically improve perception of operator in minds of its users

Challenges that need to be addressed:

1. To be able to provide this service on block chain, individual block chains for each subscriber with operator as participant would be needed. This is to avoid sharing information of other customers. Feasibility for such 1 to 1 deployments on large scale (to cover all subscribers of operator) would need to be evaluated as existing systems are focused on creating group of interested participants.
2. Customers would need to be educated on block chain concepts to be able to appreciate the merits and benefits of this new technology

4. Conclusion

Blockchain offers a completely new way of storing transaction information. The technology has already shown its capabilities in cryptocurrency space and the world believes, this will fundamentally change the way we store and process data. The use-case for distributed ledger are far and wide. However, for established industries like Telecom, which have been built on standards to enable inter-operability and high performance, technology shift will have to be gradual to avoid disruptions in current services. Telecom domain has yet to embrace Block

chains and to create a plan for its testing and adoption. The best way forward would be to cautiously explore this new technology by building consortiums or using available standard bodies to discuss and debate as being done by other Sectors.

Development of block chains could be compared to development of another revolutionary technology which is TCP/IP. Sending data as packets using IP has been in making since early 1970's. What started out as technology to send emails within participating universities has now become backbone of our digital economy and is used in almost every digital transaction that we do. However, this took about 20-30 years with contribution from various companies and institutions. Telecom Operators have also started exploring Block chain to support them in their operations. However, adoption of Block chains for Telecom use cases is in its infancy. There has not been any consolidated effort by Telecom Sector which is required for wider acceptance of this technology. So, it is safe to say that we are at least 5-10 years away from seeing major blockchain deployments within Telecom Operators space. Block chains are here to stay, though Telecom Block chain is yet to take shape.

References

Blockchain/Bitcoin for beginners. (n.d.). Retrieved from https://www.youtube.com/watch?v=xwA2TkcAQgQ

IBM Blog: Blockchains in Telco's, (n.d.). Retrieved from https://www.ibm.com/developerworks/community/blogs/IndustryBPTSE/entry/Blockchain_in_Telcos?lang=en

HBR. (Jan-Feb, 2017). Truth about Block chains. Retrieved from https://hbr.org/2017/01/the-truth-about-blockchain

Mckinsey Interview. (May 2016). How Blockchains could change the World. Retrieved from http://www.mckinsey.com/industries/high-tech/our-insights/how-blockchains-could-change-the-world

The Economist: The great chain of being sure about things, Retrieved from http://www.economist.com/news/briefing/21677228-technology-behind-bitcoin-lets-people-who-do-not-know-or-trust-each-other-build-dependable

Monitor Deloitte: Blockchain@Telco. Retrieved from https://www2.deloitte.com/content/dam/Deloitte/za/Documents/technology-media-telecommunications/za_TMT_Blockchain_TelCo.pdf

Nakamoto, S. (n.d.). *Bitcoin: A Peer-to-Peer Electronic Cash System.*

Jover, R. P., & Lackey, J. (n.d.). *dHSS - Distributed Peer-to-Peer implementation of the LTE HSS based on the Bitcoin/Namecoin architecture.*

TM Forum. (Feb 2017). *Disruptive Analysis: Blockchain and Telecom Industry.*

Analysis Mason: Nine blockchain opportunities that telecoms operators should explore

Blockchain Luxemburg: https://blockchain.info

Bitcoin: https://bitcoin.org

Wikipedia: https://en.wikipedia.org/wiki/Blockchain

Application of Block chain technology to Banking and Finance Sector in India. (n.d.). Retrieved from http://www.idrbt.ac.in/assets/publications/Best%20Practices/BCT.pdf

Blockchain technology as a platform for digitization: Ernst & Young. (n.d.). Retrieved from http://www.ey.com/Publication/vwLUAssets/EY-blockchain-technology-as-a-platform-for-digitization/$FILE/EY-blockchain-technology-as-a-platform-for-digitization.pdf

Guidelines For Author

Please use the checklist provided below to ensure that your paper meets the requirements prior to submission. In case of noncompliance to these guidelines, your paper will be excluded from being published. Please send us your paper in MS word format, not PDF files for blind review.

1. The maximum size should be 3000 words including tables, references etc.
2. Title of the paper is no more than 15 words, centered and in 16pt font.
3. Section/sub-titles are in numbered sequentially, in bold and 14pt font.
4. All text should be in 12-point Times New Roman Font, Justified, Double spaced, 1 inch margin on all four sides. Professionally drawn graphs and diagrams must be provided wherever necessary along with the manuscript.
5. Figures, tables and charts are included within the body of the paper.
6. Footnotes, figures, tables and graphs should be numbered serially and should appear at desirable place in the text itself, with proper reference made in the text. Wherever necessary, the source should be indicated at the bottom.
7. Figures, text or tables are not colored or shaded.
8. Tables or figures do not break across two pages.
9. No footnotes, but End-notes are included.
10. Paper has been checked for grammar and spelling.
11. References should be given separately at the end of the paper and arranged in alphabetical order APA style. The list should include only work the author/s has cited.

The Following Style Should be Strictly Followed

For Periodicals

The author/s name, year of publication, title of the article, journal name, volume and number, and the page numbers of the article should be provided. For example: Tobin, J. 1958. Liquidity preference as behavior towards risk. Review of Economic Studies, 25(2): 65-86.

For Books

Dubrin, A. 1984. Foundations of organizationalbehavior: An applied approach. New Jersey: Prentice Hall Taylor, B. and Willis, G. (Eds.). 1970. Pricing strategy. Princeton, NJ: Brandon System.

If an Article Has no Author, The Periodical or Newspaper is Referenced as Follows

Business Standard. 2003. TCL beats Baron in FIPB war. December 16: 12.

For Chapters in Books, Follow This Form

Srinivas, E.S. 1994. Perceived Quality of Working Life (PQWL) and organisational commitment: A study of managers in select organisations. In N.K. Gupta and A. Ahmad (Eds.), Management Research: Contemporary Issues. New Delhi: South Asia Publications.

For Working Papers, Dissertations and Papers Presented at Meetings

Sachs, J.D., Bajpai N. and Ramiah, A. 2002. Understanding regional growth in India. CID Working Paper No. 88. Center for International Development, Harvard University, Massashusetts.

For Electronic Documents

Give the author's name, if known and year of publication; or give the periodical/newspaper's name or the organisation's name asauthor. This should be followed by the full title of the document; the http, or other addresses; and the date the document was posted or accessed. Basu, I. 2004. India's thorny FDI rule under scrutiny. Asia Times.

Telecom Business Review

(Annual Journal)

SUBSCRIPTION DETAILS

	India		Foreign	
	Print	Print + Online	Print	Print + Online
Institutional/corporate	Rs. 1500	Rs. 2000	USD 100	USD 120
Individual/students	Rs. 900*	Rs. 1200*	USD 90	USD 120

*Students or Individual academicians need to provide copy of ID card & letter from relevant authorities to avail the pricing offered. Postal charges extra i.e. Rs 150 for annual subscription.

Payment can be made through Demand Draft/Cheque (at par) in favour of "Publishing India Group" payable at New Delhi and send to below mentioned address.

Despatch Address:-
The Manager,
Telecom Business Review
Plot No-56, 1st Floor
Deepali Enclave, Pitampura
New Delhi -110034
Ph - 9899775880

Telecom Business Review

A Journal of SITM (TBR) is an annual journal of Symbiosis Institute Of telecom Management. TBR is a referred journal with a process of double blind review

The Journal is published every year by SITM with the objective of participating and promoting research in the field of Telecom, IT and Business. TBR contains valuable inputs in the different areas related to technology as well as business and helps the readers to keep abreast of the current trends in the area of telecom business. Papers are invited from authors in varied areas related to telecom business such as:

- Wire-line & Wireless Networks.
- Telecom Regulation, Spectrum Allocation, Interconnection, Quality of Service (QoS) etc.
- E-Governance.
- Marketing: Trends in Telecom / IT at Global/ Indian Level.
- Financial, Accounting Issues in Telecom/ IT.
- OSS/BSS, Network Security, Telecom Network Management.
- Project Management in Telecom/ IT.
- IT Risk Management and IT Infrastructure Management.

Journal in Association With:

PublishingIndia.com

Publishing India Group

Plot No. 56, 1st Floor, Deepali Enclave
Pitampura, New Delhi-110034, India
Tel.: +91-9899775880
Email: info@publishingindia.com
Website: www.publishingindia.com

ISSN 0973-9114

9 770973 911009

SYMBIOSIS INSTITUTE OF TELECOM MANAGEMENT

[Constituent of SYMBIOSIS INTERNATIONAL UNIVERSITY-Re-accredited by NAAC with 'A' Grade]
Established under Section 3 of the UGC Act, 1956 vide notification No. F 9-12/2001-U 3 of Government of India
Symbiosis Knowledge Village, Village Lavale, Mulshi Taluka, Pune-412115.
Phone: +91-20-3911 6177 (Office Direct), 39116180. Fax: 39116181
Email: tbr@sitm.ac.in, Website: www.sitm.ac.in