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WHITE PAPER

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Cold Chain Remote Monitoring System in Dairy Industry- Need of the Hour

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Executive Summary

This white paper aims to outline the prevalent problems in Dairy Industry in India [12] with respect to Cold Chain and discusses possible & optimal solution. Milk is a highly perishable product which needs to be maintained at an optimum temperature of 4° C for it to remain fresh and maintain its shelf life. There are several losses occurring in entire milk supply chain like mixing of adulterants/extraneous matter at village level, pilferage/mixing at procurement level etcetera. However, loss in milk quality at cold chain level is one such loss in milk supply chain. To address the burgeoning demand for high quality Dairy products in country [4], cold chain for milk is moving closer towards source of production i.e. at the village level, nearer to the farmer. Cold chain [16] must be carefully monitored and managed in order to maintain high quality milk and Dairy products. Due to losses in milk temperature at chilling level and even during transportation, price realization of milk gets reduced. All stakeholders suffer due to lower returns on milk price realization; producer (farmer) gets less price for milk from market [7], end consumer gets low quality of milk and other Dairy products at escalated prices, Dairy Companies gets lesser value for milk sold in market and incurs high capital and operational expenditure on cold chain operations and eventually the entire Nation loses due to weak economic returns and loss of export opportunities.

Apex body and other Dairy governing institutions have been investing money with the help of World Bank and other prestigious financial institutions for strengthening the cold chain level of Dairy Industry in India. Bulk Milk Cooler (BMC) [1, 3] is one way of extending towards farmer level as a cold chain equipment. BMC level set up requires on an average twenty-five lakhs including all milk chilling equipment, site readiness, DG, cleaning equipment and other accessories. Our studies suggest, at a country level there are approximate 26,000 BMCs spread across many Dairy companies. However, most of the milk is not utilized for premium products like UHT milk, ice creams, cheese and chocolates. Even with state-of-the-art BMC machinery for chilling milk several operational procedures are neglected. On a national average, milk chilling is delayed by one hour at different collection & chilling centers. Cooling equipment is kept ON even when the temperature reaches 4° C with different components still utilized when requirement is not there. This severely reduces cold chain equipment shelf life and its value. In such scenario due to absence of effective cold chain remote monitoring solution high investment [1, 13] stands non-worthy made by apex bodies.

All the stakeholders get affected when milk quality goes down as almost entire Dairy supply chain is devoid of optimal cold chain. With reduced returns at each step, Dairy farmer tries to move away from Dairy occupation towards any alternative source of occupation. India being proficient in milk production lacks Technological solutions especially in Dairy cold chain Industry to produce and maintain milk with a quality at par with major Developed countries. Only a handful of few Dairy companies have realized the importance of deploying remote cold chain monitoring system to help them realize better outputs and returns. Remote monitoring system [5,6] can check in effective cold chain with cloud analytics to help provide preventive, proactive support and maintenance.

With drain of huge invested money, effective cold chain monitoring solutions become the need of the hour which encompass IoT (Internet of Things) [8,9] and Cloud based solutions to minimize the losses right from beginning. With strengthening of Dairy supply chain each stakeholder gains –eventually resulting in gain of Nation.

Context

A cold chain is a temperature-controlled supply chain. An unbroken cold chain is an uninterrupted series of storage and distribution activities which maintain a given temperature range. Cold chain must be carefully monitored and managed in order to maintain high quality milk & Dairy products. Any breach of the cold chain [16] can have a severe impact on product quality, causing problems such as sourness, unpleasant taste and odour, texture and appearance problems, aggregation, colour changes, pH value reduction and other health issues linked with bacterial growth. Desirable temperature for preserving optimal freshness and taste in milk and Dairy products is 4° C. Maintaining this temperature is critical during every stage of transport and storage from the Dairy farms to the supermarket shelves. Studies have shown, for example, that every 2 °C increase in the storage temperature of milk reduces its shelf life by 50% and adversely affects the quality.

Challenges

Right from the very moment milk leaves the udder of a cow it starts developing bacterial count. Thus it is required to be kept at an optimum temperature of 4° C to maintain its utmost quality. In entire Dairy supply chain starting from production till cold chain logistics level milk continuously loses its quality value due to various reasons. Although, absence of cold chain [16] accounts for majority of milk quality drop. For chilling, BMCs are being used which comes in various sizes and are slowly moving in-roads to be deployed at even village level to let milk retain its quality.

In developed countries, BMCs are deployed right at farm level to maintain milk quality but our Country still falls behind over this parameter. BMCs which comprise of in-built machines are utilised several times even when the milk has attained its optimum temperature. Alternatively, when milk has not even reached optimum temperature in BMC machines are switched off. In other instances, DG and Grid attached with BMC are not checked and DG keeps running when it is not required. Cleaning in Place; a major component for BMC maintenance is avoided by BMC

personnel at times and even, if done, is via cold water. At many instances pilferage too happens through BMC. All such neglected operations affect the milk being poured and kept in BMC; severely affect the working of BMC.

Setting up a BMC be at Collection/Chilling center or village level requires a sizeable investment [1,13], but to monitor operational parameters remotely via technological solutions is rare. Eventually this results in asset degradation and its associated components losing or wearing out soon before their actual shelf life. In the entire chain of Dairy Industry several stakeholders lose out due to this but primarily four major stakeholders suffer.

- **Producer (Dairy Farmer):** With reduced quality of milk, price realization of milk in market also goes down [7] and hence the profit of Dairy Company. Less value is returned to Dairy farmer and even less profit sharing on basis of co-operative principle are shared with farmer.
- **Consumer:** Low or reduced quality of milk in market makes end consumer reduce the consumption of milk products. Consumer does not get satisfied even after paying high value for milk and spends money on other alternatives for nutritional requirement.
- **Dairy Companies:** With sizeable amount of investment [1,13] on BMCs and its associated components for setting up BMCs at different locations of country, Dairy companies looks for handsome returns on milk being sold in market. In absence of effective remote monitoring s olution at cold chain level it reduces the BMC asset value and even milk quality value. Not even they suffer losses due to reduced milk value realization, but also due to early wearing out of BMC and associated assets, which goes well above twenty lakhs per center. Operational and Capital expenditure for Dairy Companies keeps escalating on account of this.
- **Nation:** For setting up infrastructure for Dairy supply chain in terms of chilling centers and cold chain Logistics Country gets funding from World Bank and other International apex bodies. To show optimum results and increased earnings from Dairy Industry, Country invests huge money repeatedly on developing these chilling units; but due to minimal application of IoT [8,9] based technological remote monitoring system this cycle of

reduced milk quality output continues. This results in huge expenditure but lowered earnings and returns as expected lowering the economic value of the country. Even taxpayer's money is utilized to strengthen the Dairy Industry but eventually all stakeholders in complete chain suffers due to scarcity or less knowledge over remote monitoring solution as cold chain system.

Proposed Solution

The Internet of Things (IoT) [8,9] is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Remote Monitoring (RMON) is a standard monitoring specification that enables various network monitors and console systems to exchange network-monitoring data. Health care Industry has already leveraged upon IoT and RMON for monitoring health, preventive diagnosis, in-patient care, disease management. Similarly, other Industries are banking upon these Technological solutions with the help of sensors and wireless mechanism for seamless transfer of data and near real time analysis.

Introduction of cold chain monitoring solution which enables Internet based, near real-time management of BMCs with enhanced reporting, pilferage reduction & tamper proofing features for improved monitoring [5, 6] and efficiency of BMC is need of the hour. The state of the art, microcontroller-based solution should address advanced automation and control requirements of BMCs. The digital locking and improved tamper proof management system will help reduce pilferage and ensure quality of milk. Cold chain monitoring system [6] would be powered by the cloud based platform to enable preventive diagnostics & remote monitoring of various parameters of BMC such as temperature, volume, Cleaning-in-Place (CIP) events, efficiency, malfunctioning and potential misuse. SMS alerts need to be provided over mobile phone to various stakeholders. Daily/Weekly/Monthly reports of BMC operation and related milk storage data also to be incorporated over mobile phone and internet.

Effective Remote Monitoring cold chain system would bring in:

- **Optimal BMC utilization**
- **CIP protocol adherence**
- **Optimum power consumption**
- **BMC rating**
- **Pilferage Control**
- **Near Real Time Operational Analysis**

With effective remote monitoring system [6] one can trace the quantity & quality of the milk. Ensures that the milk chilling & milk lifting has done timely. One can effectively trace the milk from collection center to production center and to ensure there won't be any theft or pilferage

BMCs advantages won't be reflected in full till RMON system is mounted to help increase the overall efficiency and functioning of BMC. This implicitly enhances the performance of collection/chilling centre with milk quality improvement. The same BMC which might be utilized for ten-twelve years may be extended to twelve-fifteen years saving stupendous money involved both as capital as well operational expenditure. Moreover, due to near real time reporting of this system, management practices of collection/chilling centre too gets improved and healthy practices & technology for monitoring is promoted across all such centres. When Dairy Companies earns more or saves more, eventually farmer earns more and consumer benefits. This entire gambit ensures proper asset utilization with rightful controlling parameter deployed across length & breadth of country.

An overall pictorial representation of cold chain Monitoring system with features is laid down below:

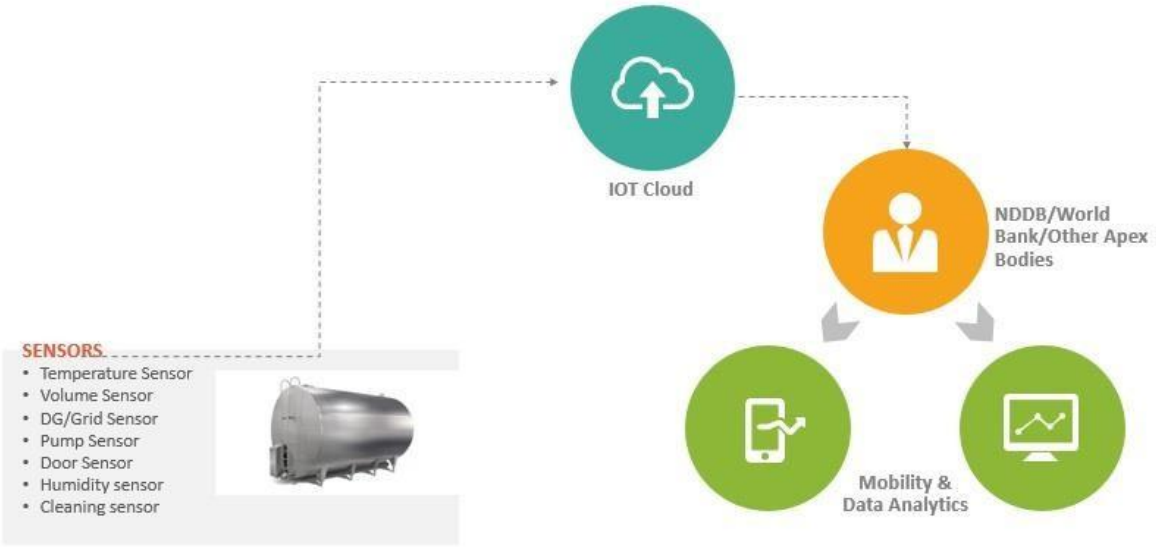

Figure 1: Cold chain Monitoring system features

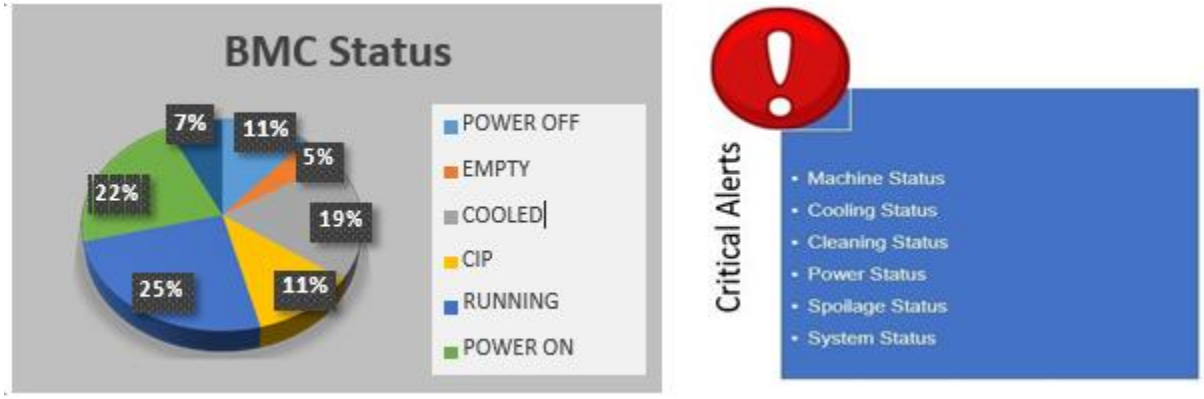

Figure 2: Tentative Monitoring dashboard representation of BMCs

Tangible Gains

With effective cold chain monitoring solution following added advantages can result:

- **Automatic Inspection and Labour reduction**
- **Premium milk pricing / Cold Chain adherence (lower Bacterial count) CIP Adherence**

- **Power/Fuel expense management (DG / Grid)**
- **Shelf-life / optimized CU (compressor machine) running time**
- **Optimized logistics / lifting management**
- **Preventive, proactive support and maintenance**
- **Automatic problem diagnostic (cooling rate check)**
- **Optimized BMC operation (Insulation loss)**
- **Auto calibration**
- **Proactive analytics for affirmative intervention**

Key Result Area	Cold chain RMON system impact	Value Realization	Description
Automatic inspection and labour reduction	50% ↓	0.4 paisa/ litre (Assuming INR 12,000 is spent per year per BMC inspection)	Due to daily, weekly and monthly reports and near real time information and Critical Alerts
Prevention of milk rejection and premium milk pricing due to lower bacterial count	0.3% ↑	6.6 paisa/ litre (Assuming milk price is Rs. 22/ litre)	Due to near real time detection of temperature, Over cooling/ under cooling detection and CIP adherence, lifting time
Power/Fuel expense management, Fraud Detection	10% ↓	3.5 paisa/ litre (Assuming 35 paisa/ litre is spent on power/fuel)	Due to optimization of CU running time, slow cooling rate detection and Power Source monitoring (DG running time etc.)
Preventive, proactive support and maintenance	30% ↓	0.6 paisa/ litre (Assuming 2 paisa / litre spent on maintenance)	Due to near real time monitoring of the operation of BMC, Insulation loss, CU/Agitator inaction detection and analysis and comparison of each day's operational data of BMC
Revenue upside from premium milk	30% ↑	INR 3-5 per litre	Low MBRT milk – can be sold as premium milk and value added products

Figure 3: Key benefit areas

Actively deploying cold chain remote monitoring system [6] will help the entire Dairy supply chain at each stakeholder level with increased earnings. The proposed solution will encourage usage of smaller BMCs with such IoT solutions with sensor technology embedded to bring in monitoring right from production stage of milk. It facilitates for easy maintenance of expensive assets and even add on to their shelf life. A nation is known by its strengthened infrastructure and Technology advancement in place. With surplus milk in Country, the remote monitoring cold chain system can help Country increase its export base for milk products with enhanced quality yield to fulfil the global demand [4] of Dairy products.

Summary & Recommendations

With 2G and 3G already reaching in-roads of Rural India aligned with honourable Prime Minister's Digital drive, remote monitoring and cloud solutions is not a distant dream. Sensors forming a major part of many electronics consumer industries to help monitor and reduce the rampant energy wastage and optimizing the working processes. In Dairy industry, altogether this technology is still in nascent stage and not being actively deployed. With remote monitoring cold chain solutions, the working capability of entire Dairy supply chain can be completely revolutionized to modernize and digitally uplift the Rural Dairy economy. With continuous up-gradation of chilling centers and many more to be opened in coming time, the challenge of managing these high value assets with associated accessories & parts becomes humungous. There comes the solution of maintaining a futuristic monitoring & controlling cold chain solution which wipes all the operational problems and let entire Dairy supply chain start churning huge profits out of it.

With several policies and World Bank projects [13] coming in to modernize the Dairy sector of country, the cold chain solution becomes imperative. With every single rupee spent, direct profits need to be turned out and the investment made should come in form of better earnings to farmers, better product to consumers and clean milk production for Country at entire Dairy supply chain. On rough estimates even if 50% of entire BMCs are owned by Dairy Companies, it gives a picture of

3250 crores of BMCs in country (considering BMC value and its associated assets cost as 25 lacs). These BMCs needs to be retrofitted with remote monitoring solution and any new proposed BMC to directly incorporate in its specifications such remote monitoring systems as mandate. Our studies clearly show that with remote cold chain monitoring solutions along with BMCs, a Dairy Company can gain significant additional revenue [14] per liter of milk for Premium quality maintained. Considering on a conservative estimate, average size of BMC in country as 2000 liters, an annual return for Dairy Industry would come to 5.2 crores. This much money can be

fairly distributed to Dairy farmers which will help them purchase better breed cattle with fodder and upscale their Dairy management with quality yield of milk.

Already many Dairy companies have deployed remote monitoring cold chain solutions to strengthen up their cold chain. Dairy Unions like Tumkur Union (KMF Karnataka), BAMUL (KMF Karnataka), Kolar Union, Aavin (Tamil Nadu), Milma (Kerala) etcetera have been continuously scaling up on such solutions and realizing better operational results with improved earnings. Even Dairy farmers in the region are able to fetch better prices for their milk from Dairy companies and are happy to have such Technological solutions deployed.

clear context of above underlying added advantages and cost reduction with significant improvement in functioning of BMCs deployed across length and breadth of dairy supply chain, cold chain monitoring solution becomes the heart beat for the same. It has a crucial aspect on making our Rural India more digitally alive and strengthens Dairy supply chain. Cold chain monitoring solution has the capability to turnaround of looking at cold chain logistics domain as well. With such monitoring and controlling solution, high value assets can be optimally utilized in a much more effective manner. At policy level there is a stern requirement of incorporating these solutions within specifications while buying for BMCs. That is where the Dairy industry in India can look forward to strengthen its roots at par with developed countries where remote monitoring solutions are pervasive.

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References

1. Model Bankable Project On Bulk Milk Cooling Units (https://www.nabard.org/pdf/Model_scheme_on_Bulk_Milk_Cooling_Centers.pdf)
2. National Dairy Development Board (http://www.nddb.org/about/genesis/significant/facts)
3. Innovative-procurement-practices-help-dairy-sector-in-India (https:/nl4worldbank.org/2016/07/06/innovative-procurement-practices-help-dairy-sector- in-india/)
4. India: Increasing demand challenges the dairy sector (http:/www.fao.org/docrep/011/i0588e/I0588E05.htm)
5. News for Schneider Electric Recognized for remote monitoring solution that improves milk quality in new economies (http:/www2.schneider-electric.com/corporate/en/press/news/viewer news.page?c_filepath=/templatedata/Content/News/data/en/local/corporate/institutionnal/2015/07/20150717_schneider_electric_recognized_for_remote_monitoring_solution_thatimpr.xml)
6. Coldchain Management application (http:/www.stellapps.com/index.php/cold-chain-management-contrak-2/)
7. The Hindu news for Falling milk procurement prices put dairy farmers in a churn http:/www.thehindubusinessline.com/economy/agri-business/falling-milk-procurement-prices-put-dairy-farmers-in-a-churn/article8452160.ece)
8. grant-thornton-investing-in-the-internet-of-things-spotlight-on-dairy (http:/www.grantthornton.ie/globalassets/1.-member-firms/ireland/insights/publications/grant-thornton-investing-in-the-internet-of-things-spotlight-on-dairy.pdf)
9. 'Technology Digest' News for 'Internet of things' (http:/www.trai.gov.in/WriteReadData/Publication/Document/20150824040736955443 1Jul y,%202015%20(1).pdf)

10. Propelling Growth in the Dairy Industry - A Perspective – TCS (http://www.tcs.com/SiteCollectionDocuments/White%20Papers/Propelling-growth-dairy- industry-0315-1.pdf)
11. 'FREE PRESS' News for Significance of the Dairy Industry (http://www.freepressjournal.in/wp-content/uploads/2016/03/FPJ-IMC-Forum-Dairy- Industry.pdf)
12. Government of India and World Bank sign US$ 352 Million Agreement for National Dairy Support project (http://www.worldbank.org/en/news/press-release/2012/04/13/project-signing-government-of-india-and-world-bank-sign-us-352-million-agreement-for-national-dairy- support-project)
13. ICT application in a dairy industry: The e-experience of Amul (www.planningcommission.gov.in/reports/sereport/ser/stdy_**ict**/3_amul.pdf)
14. On links of cold chain logistics for dairy products enterprises 15-20 (jocpr.com/vol6-iss7-2014/JCPR-2014-6-7-767-771.pdf)
15. Use of cold chains for reducing food losses in developing countries (http://www.postharvest.org/use%20of%20cold%20chains%20pef%20white%20paper%2013-03%20final.pdf)

Authors' Profile

Mr. Ranjith Mukundan – Co-Founder, Stellapps Technologies (P) Limited

Has more than 20 years of experience in the global Telecommunications industry. He is an M.S in Telecom & Software Engineering from Illinois institute of Technology, Chicago. He is a regular Speaker at various International Forums on Real-time Multimedia IP Communications & Applications related Areas. He has served on the Board of IMS forum, Spokesperson of the SIP forum and was also the member of the CEO nominated research board at Wipro Technologies. From 2011 onwards, he has been instrumental as an entrepreneur of Stellapps Technologies making Dairy Industry technology embedded focused on developing & deploying Smart systems across Dairy ecology.

Mr. Ravishankar G. Shiroor – Co-Founder, Stellapps Technologies Private Limited

Has more than 20 years of experience in the global Telecommunications industry. He is an M.Tech in Telecommunications from IIT Madras. In the last few years he has been an entrepreneur focused on developing & deploying M2M, Smart Systems and Internet of Things based end-to-end solutions specific to industry segments specific emerging economies like India. His company, Stellapps Technologies, is making significant inroads in to applying these technologies in to Dairy and Agriculture sectors.

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Has experience of 3.5 years spanning across different companies like Infosys, Escorts and Stellapps. With B.Tech in Computer Science and MBA from IRMA has a keen interest in business analysis and strategy. Varied exposure towards Systems engineer to Business development to Pre-sales has accorded with high level of Industry reflection.

Company Profile

Stellapps Technologies (p) Ltd., Bangalore is an IIT-Madras incubated start-up founded by a group of IIT- ians and technologists with rich industry experience. Stellapps' innovative applications leverage Inter of Things (IoT) & Big Data to improve Agri-Dairy supply chain, including milk production, milk procurement, cold chain, animal insurance and farmer payments. The SmartMoo™ brand of Stellapps is capable of supporting hundreds of millions of liters of across millions of milch animals spanning millions of farmers. Stellapps SmartMoo™ suite of applications analyse & crunch the received data before disseminating the analytics & data science outcome to various stakeholders over low-end and smart mobile devices. We have products as in SmartFarms™, smartAMCU™, and ConTrak™, AgRupay™ and MooKare™ which aim to connect entire dairy supply chain from milk procurement to milk cold chain logistics level.

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