GRAPH MODELS FOR NETWORK DEVELOPMENT IN PRI SYSTEM

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Abstract:

In computer science many graph models have been used in designing infrastructure which came out to be quite successful but one problem with those they are not easy to imply. Interconnected structure is a magnificent art of computer science. In this paper we are introducing a new graph model which will help in designing the interconnected model at ease and in turn will help in further progress in computer science. Specifically in this paper with the newly introduced model, we are highlighting how blocks and grampanchayats are connected and also interconnected in PRI system. In practice this model is appearing quiet beneficial in network establishment. This model is not only strongly capable of handling small no of blocks but also strictly avoids loss of data resources. In any circumstances addition of new blocks can easily be handled by linking the new blocks with the existing ones. Thus the model proves to be dynamic which makes it unique. The empirical study of this model states that all the blocks are strongly interconnected and also to the central one, thus this property clarifies that blocks with a central head block can be designed and also networking can be established easily and efficiently. Thus the present paper is attempting to analyze the benefits of the present model which is no doubt much more efficient in comparison to other available model.

Keywords: *PRI, Graph, Pascal, Regular, Network, Block, Grampanchayats.*

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1. Introduction:

Graph theory is becoming increasingly significant as it is applied to various fields like mathematics science and technology, social science network and many others[4, 9]. However, it is being highly influential in the fields as varied as biochemistry (genomics), electrical engineering (communication networks and coding theory), computer science (algorithms and computation) and operations research (scheduling) [10, 11, 12]. The powerful combinational methods of graph theory are used to prove fundamental results in other areas of pure mathematics. Let G = (V, E) be a graph without loops where V and E is denoted as vertices and edges respectively.

The present work deals with the problem of regional balance, backwardness and effective communication. It is seen in terms of inter-block disparities. The emphasis has been given to measure the levels of backwardness in terms of economics performance, social and educational factors. To remove this backwardness it is necessary to develop proper intra-block communication scheme for better communication between the backward areas and to undertake schemes like social development programmers. In this paper we formulate technique of communication algorithm to communicate between the backward areas on the basis of social factors.

The government, the biggest producer of vast amount of efficient information and data is of utmost importance. Due to the advent of information and communication technology (ICT), the e-government applications are being implemented to improve government functioning by exploiting ICT potential. In order to meet government data needs efficiently and effectively, the proper networking as well as databases need to be designed conforming to standard database design principles.

The implementation of e-governance will implement in better and faster communication of data in the blocks and its lower level. This can be done only by proper designing the communication topology and network between the blocks using some special graph models[2]. This new

networking model will help in functioning e-governance successfully, efficiently and effectively in the higher number of blocks under each Zilla-Parisad.

2. Terminology:

2.1 Graph:

An undirected, simple, connected graph G is an ordered triple (V (G), E (G), f) consist of

(i) a non empty set of vertices $n \in V$ of the graph G

(ii) a set of edges $e \in E$ of graph G

(iii) A mapping f from the set of edges E to a set of unordered pair of elements of V.

2.2 Topology:

Topology is the structure of network showing the connection of one communicating device to others. It may be static and dynamic. Dynamic topologies are efficient but circuitry is complicated and costlier.

2.3 Network:

A network is a group of connected, communicated devices such as computers, and switches. An internet is the combination of two or more networks that are communicating with each other. The internet today is not a simple hierarchical structure but it is made up of wide and local area networks joined by connecting devices and switching stations. Therefore an internet is nothing but "the network of networks i.e. Super-network [12]."

2.4 PRI:

PRI (Panchayati Raj Institution): It is the grass root unit of self government. It has been proclaimed as the vehicles of socio-economic transformation in rural India. With the introduction of three tiers Panchayati Raj System, every village aims to be a republic unit and the powers of panchayats has been transferred into reality.

Levels In PRI:

- Zilla Parishad (district Level)
- Panchayat Samiti (block level)
- Grampanchayats (village level)

2.5 Regular Graph:

In graph theory, a regular graph is a graph where each vertex has the same number of neighbors; i.e. every vertex has the same degree or valency. A regular directed graph must also satisfy the stronger condition that the indegree and outdegree of each vertex are equal to each other. A regular graph with vertices of degree *k* is called a *k*-regular graph or regular graph of degree *k*. A regular graph is a graph without loops and multiple edges. A graph is regular if the number of edges incident with a vertex is constant. This constant is called the valency, or the degree of the graph.

2.6 Pascal Graph:

An undirected graph of n vertices corresponding to PM (n) as an adjacency matrix is called Pascal Graph (n), where n is the order of the Pascal graph.

2.7 Routing:

Routing is the process of moving packets across a network from one host to an. It is usually performed by dedicated devices called routers [12]. Routing is a key feature of the Internet and it, together with a great deal of deliberate redundancy of high capacity transmission lines (e.g., optical fiber cable and microwave), is a key factor in the robustness (i.e., resistance to equipment failure) of the Internet.

3. Overview of Panchayati Raj System of India:

3.1 The System:

Panchayati Raj Institutions – the grass-roots units of self-government – have been proclaimed as the vehicles of socio-economic transformation in rural India. Effective and meaningful functioning of these bodies would depend on active involvement, contribution and participation of

its citizens both male and female. The aim of every village being a republic and Panchayats having powers has been translated into reality with the introduction of the three-tier Panchayati Raj system to enlist people's participation in rural reconstruction.

3.2 Nodal Agency:

In the State level, **Panchayats & Rural Development Department** of the Government of West Bengal is the Nodal Agency for Implementation, Supervision & Monitoring of the major poverty alleviation programmers in the rural areas of this State. At the District-level, **Zilla Parishad** is the implementing agency for the same.

Under three-tier system of democratic decentralization, Zilla Parishad is the apex body at the district level followed by **Panchayat Samitis** at Block level as second-tier and **Grampanchayats**.

3.3 PRI Structure:

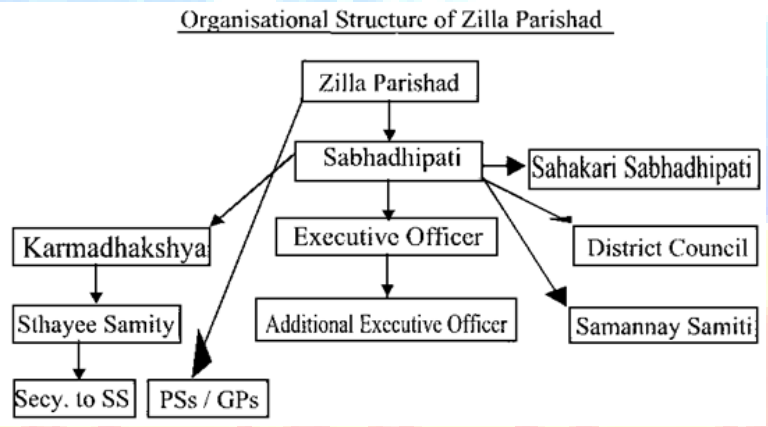
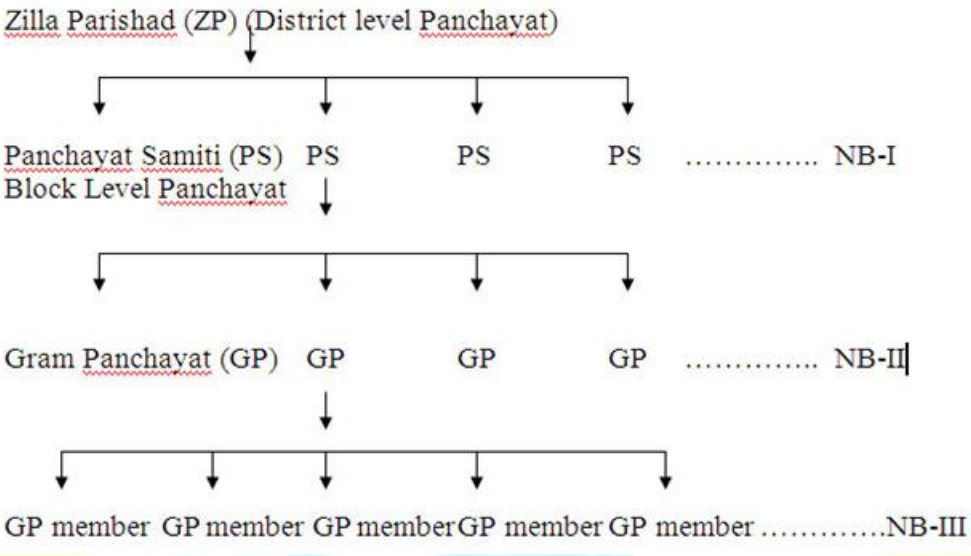


Fig1: Tabular chart of PRI system



The above chart represents Rural Local Governance System (Panchayati Raj Institutions or PRIs)

NB-I: All the Panchayat Samitis within the geographical limit of a district come under the said District Panchayat or Zilla Parishad.

NB-II: All the Grampanchayats within the geographical limit of Panchayat Samiti come under it. Panchayat Samiti and Development Block is co-Terminus.

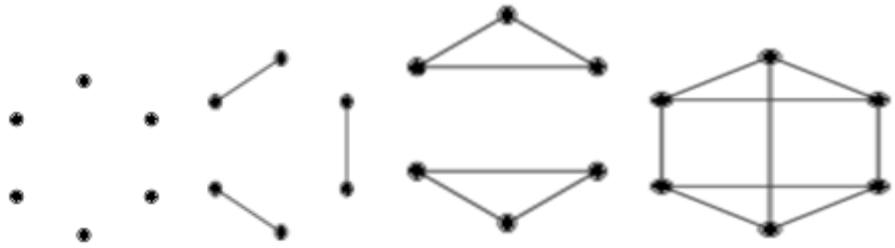
NB-III: A Grampanchayats will have at least five and maximum of 30 members. Each member has a specified area and voters (constituency) that he represents which is called Gram Sansad (village parliament)

4. Overview of Regular Graph:

4.1 Definition:

As discussed in section 2.5 regular graph is a graph wherein all nodes in the graph have the same degree. In an *r-regular* graph, all nodes have a degree *r*. The number *r* is called the regularity of a regular graph. Regular graphs are undirected. They need not be connected. So, a *0-regular* graph is a set of nodes; a *1-regular* graph is a set of disconnected edges; and so on.

Examples of some regular graphs



(a)0-regular graph (b)1-regular graph (c)2-regular graph (d)3-regular graph

Fig2: Different types of regular graph

4.2 Properties of Regular Graph:

A regular graph is a graph wherein all nodes in the graph have the same degree. In an r-regular graph, all nodes have a degree *r*. The number *r* is called the regularity of a regular graph. Regular graphs are undirected. Since the total degree of any graph is even (2 * no of edges). In the fig 2 (a) represents a 0-regular graph, (b) represents a 1-regular graph, (c) represents2-regular graph and (d) represents 3-regular graph. Regular graphs with odd regularity cannot be constructed with odd number of nodes. For example, we cannot have a 3-regular graph with 7 nodes. Degree distribution is uniform for regular graphs. Regularity need not correspond to connectivity. On a related note, centrality distribution need not be uniform for regular graphs. It can be skewed. This is clear from the graph below in figure 3.

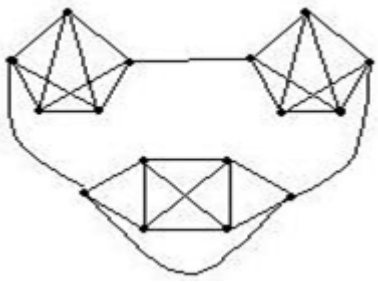


Fig3: Non uniform distribution of regular graph

What this implies is that regular graphs are robust only to a certain extent. They ensure uniform degree distribution but not uniform centrality distribution. Centrality distribution is a better measure of robustness than degree distribution.

4.3 Advantages of Regular Graph:

Regular graphs are with valency k. so their edge connectivity and vertex are powerful. Graph density is also very high. Since there is no existence of self loop and parallel connectivity in most edges so it is very efficient. Number of edge distribution of each node is least. Bandwidth utilization will be very good. Because of uniform distribution of edges among the nodes, it is expected in average case all the links will be used. Due to uniform distribution of links even in a higher traffic the network will give the best performance. Regular graph has the minimum number of cut-set and high reliability. Thus the damage of few links may not disconnect any node from the system. Regular graph allows extension of this model in the distributed environment due its decentralized architecture.

4.4. Mathematical Explanation of regular graph:

The maximum vertex connectivity one can achieve with a graph G of n vertices and e edges (e>=n-1) is the integral part of the number $\lceil 2e/n \rceil$; that is $\lfloor 2e/n \rfloor$. Regular graph uses this concept [14].

The degree of each node is exactly $\lceil 2e/n \rceil$ if $\lceil 2e \rceil$ is exactly divisible by n.

This idea is extended this even when the exact regular graph formation is not possible. In that case alternative method is followed stated below.

- Firstly, a graph is constructed such that each node of the graph has the connectivity $\lfloor 2e/n \rfloor$.
- Secondly, remaining edges are added to the graph.
- Now the remaining edges are less than the number of nodes in the graph
- The nodes are added in such a way so that no node gets the connection twice.
- The nodes getting the connection in this step have degree one more than other node.
- So the degree among different nodes varies only by one.
- This can be avoided if the edges are provided so that twice the numbers of edges are divisible by number of vertices.

Generally graphs are used to construct the network model. Networking is an essential feature now a days and it exhibits a great reliability in communication among human being in various sectors.

Thus according to the rules whenever the adequate blocks are available it will be rearranged according to the situation.

4.5 Reconstruction of regular graph:

n=6, e=10 so d= [2*10/6] = 3 where n is taken as nodes, e as edges and d as the degree of the graph. But 2*10%2 = 2, so there are two extra edges. The two connections can be distributed in graph since it is less than no of nodes in graph, if it is more or equal to n we can add one more node in graph.

5. Overview of Pascal Graph:

In this section we are describing about how Pascal graph can be represented, how advantageous and beneficial will it be in designing topology using Pascal graph properties.

5.1 Pascal Graph Model Used as Topology:

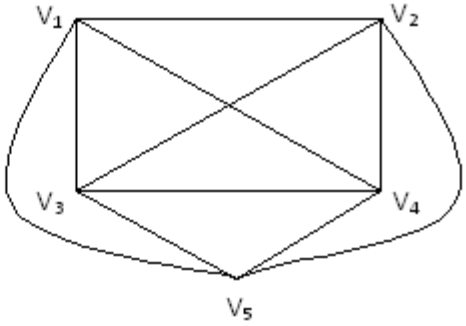
An undirected graph of n vertices corresponding to PM (n) as an adjacency matrix is called Pascal Graph (n), where n is the order of the Pascal graph.

5.2 Pascal Matrix:

An (n x n) symmetric binary matrix is called the Pascal Matrix PM (n) of order n if its main diagonal entries are all 0's and its lower (and therefore the upper also) consists of the first (n-1) rows of Pascal Triangle modulo 2. Where $pm_{i,j}$ denotes the element of i^{th} row and j^{th} column of the Pascal Matrix[5, 6, 7, 8].

An example of Pascal graphs along with associated Pascal matrices is shown in next section

Pascal Graph (5),



PG (5)

Fig4: Pascal graph

Pascal Matrix (5),

	V_1	V2	V_3	V4	V_5
V_1	0	1	1	1	1
V_2	1	0	1	0	1
V_3	1	1	0	1	1
V_4	1	0	1	0	1
V_5	1	1	1	1	0

PM (5)

5. 3 Connectivity Properties of Pascal Graph:

There are certain pragmatic properties that make Pascal graph [13, 14] a better choice for a computer network topology over many others. Some of those properties are given below:

- PG (n) is a subgraph of PG(n+1) $\forall\ n \geq 1$.
- All Pascal Graph PG(i) for $i \leq 1 \leq 7$ are planner; all Pascal Graph of higher order are nonplanner.
- Vertex V1 is adjacent to all other vertices in the Pascal Graph. Vertex V1 is adjacent to Vi+1 in the

Pascal graph for $i \geq 1$.

- PG (n) contains a star tree $\forall\ n \geq 1$.
- PG (n) contains a Hamiltonian circuit [1, 2, 3,……, n-1, n,1].
- PG (n) contains wn-x (wheel of order n minus an edge).
- If k=2n +1, n is a positive integer, then Vk is adjacent to all Vi.
- All Pascal Graph of order ≥ 3 are 2-connected.
- No two even number of vertices of a Pascal Graph are adjacent.
- There are at least two edge disjoint path of length ≤ 2 between any two distinct vertices in PG (n), $3 \leq n$.
- If Vi is adjacent to Vj , where j is even and |i-j|>1, then I is odd and Vi is adjacent to Vj-1.

• Let det(PM(n)) refer to the determinant of the Pascal matrix of order n. Then, det(PM(n)) = 0, for all even $n \geq 4$.

• Define e(PG(n)) to be the number of edges in PG(n), (( )) _(1) log 3_ 2 c *PG* $n \leq n -$.

• Det(PM(n)) is even for all $n \geq 3$.

5.4 Advantages of Pascal graph:

Pascal Graph (n) is sub graph of PG (n+1). So, blocks or nodes can be removed without any effort. It is planner up to PG (7). So, it's easy to implement. Again node-1(n) is always connected to all other nodes. So, node-1 can be considered as MAJOR (main block). Node n_1 is connected to n_{2+1}. So a sequence of connection is inbuilt.

6. Use of Graph Model in PRI System:

6.1 Interconnection of Grampanchayats:

In PRI system the grampanchayats are interconnected using regular graph[14]. Hereunder the establishment of networking is explained with a suitable regular graph model.

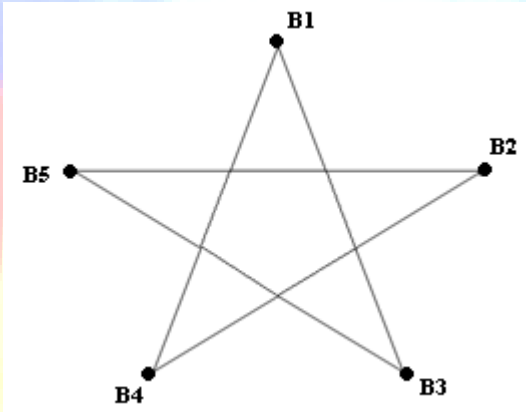


Fig 6: A 2-regular Graph

In figure 6 there are

1. 5 nodes (B1, B2, B3, B4, B5) represented as grampanchayats [GP] within a blocks. All the grampanchayats are equally interconnected with each other in the same way.
2. The connectivity are equal i.e. all the nodes have same no degree of 2.

3. Acc to mathematical calculation degree of the nodes follows [2*e/n]
4. The above formula works well in ideal situation.

Mathematical illustration of regular graph is highly applied in practical areas i.e. PRI system.

In the formula [2*e/n], n= no of nodes, e= no of edges and d=vertex connectivity but in PRI system the n becomes the blocks, e are the connections inbetween and d is the degree or grampanchayats connectivity.

6.2 Addition of Two New Blocks:

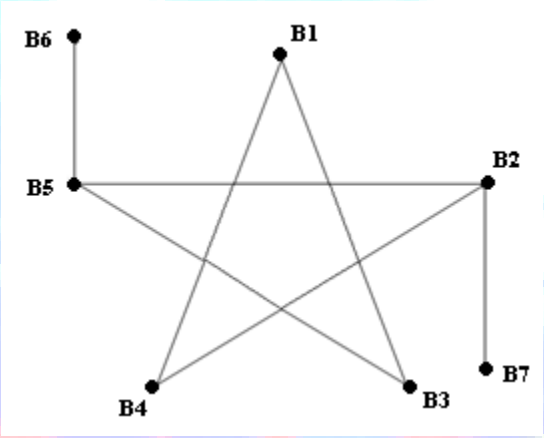


Fig7: A 2-regular graph with addition of two new blocks

A network of blocks is shown in figure 7 where two new GP of PRI system- B6 and B7 are come into existence. They are connected with the GP B5 and B2 respectively. With the rise of these new GP the degree of the GP B5 and B2 changes from 2 to 3. Thus the degree variation is of 1 acc to the rule. The GP are connected in such a way so that they don't violate the mathematical explanation of the regular graph. Therefore regular graph helps in establishing network in PRI.

6.3 Interconnection of Blocks in PRI system:

The blocks in the PRI system are also connected using regular graph model like the grampanchayats. The diagrammatic explanation is given hereunder.

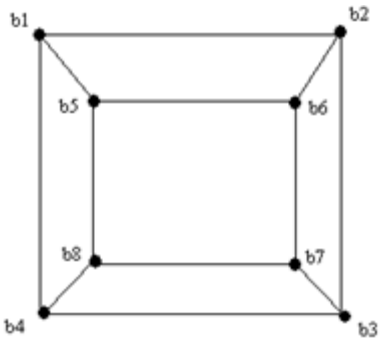


Fig8: A 3-regular graph showing interconnection of blocks

b1, b2, b3, b4, b5, b6, b7, b8 are denoted as the blocks in the prototype model in PRI as shown in figure 8. All the blocks are connected in regular graph modular way. The degree of every 8 block is 3. Thus this approach of interconnecting the blocks with the newly invented regular graph theory is quite successful.

6.4 Connection of Grampanchayats with Blocks

This is the whole new concept which is discussed in this paper. The concept has always tried to represent the different computer network topologies using appropriate graph models. In this present study Pascal graph is researched again and a new characteristics has been discovered. From the perspective of network topologies Pascal graph and its properties were first studied more than two decades back. Since then, a numerous graph models have emerged with potentials to be used as network topologies. This new property is guaranteed to make an everlasting mark towards the reliability of this graph to be used as a substantial contributor as a computer network topology. This shows its credentials over so many other topologies. This study reviews the characteristics of the Pascal graph and the new property is established using appropriate algorithm and the results.

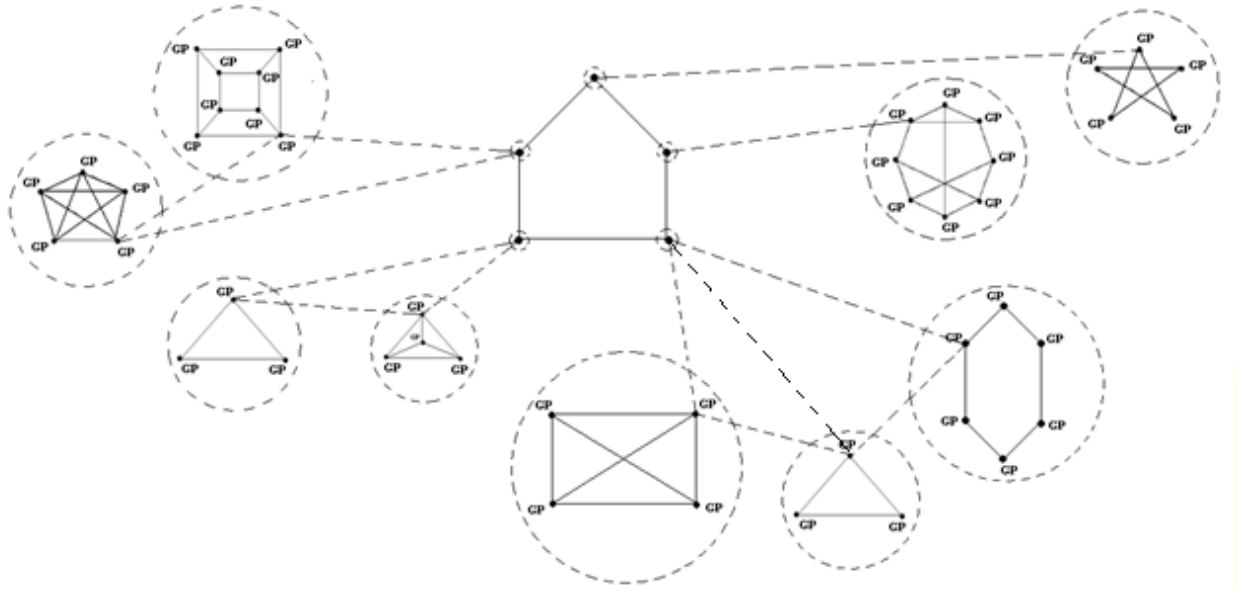


Fig9: Connection between blocks and grampanchayats in PRI system.

The connection between blocks and the grampanchayats is shown using Pascal graph model where the blocks are denoted as 'B' and the grampanchayats are denoted as 'GP'in figure 9. The representation of the Pascal relationship between the block and the gram panchyats is done by dotted line and the firm line represents the Regular graph network.

There may occur problem at times in communicating to all GPs if there are too many grampanchayats present in one block. As a result creation of too much congestion in transferring information and messages from one GP to other is highly possible. In order to solve the problem the blocks with higher no of GPs are divided into groups. But there may be a question in what basis the GPs are to be divided. In this situation in order to maintain uniformity, a strict rule is followed. Divisions are made in a way that each group will consist a min of 5 GP to max of 6 GP. This can be further explained with appropriate diagram here under.

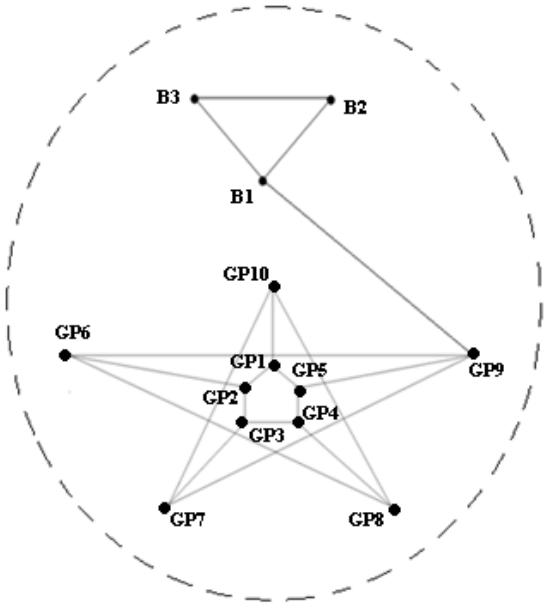
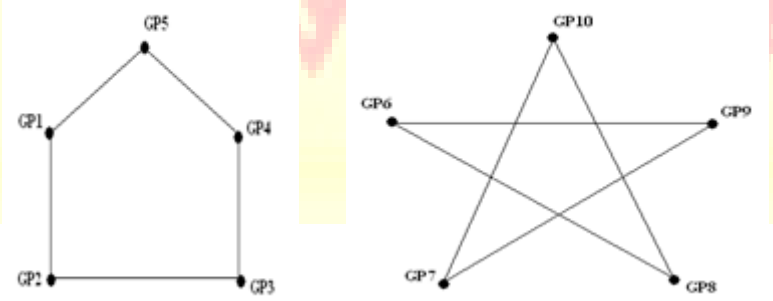


Fig10: Subgrouping of blocks/GP

A 3-regular graph repesenting a block with 10 GP ad 2-regular graph showing blocks and Pascal graph is repersenting the connetion between blocks and grampanchyats.There are 10 GP as shown in figure 10 so network establishment and connecting 10 GP together can create a mess. So to overcome the problem the whole diagram will be divided into 2 group, each containing of 5 GP. The benefit of doing this will launch communication between the GPs much more easily. Thus the main objective of this paper will be justified. The above mention scenario is again illustrated with suitable digram given hereunder.



(A) (B)

Fig11: (A) and (B) are the subgraph of Fig10

There can be also circumstances where two groups of GPs taken respectively as separate nodes and a block itself a node may altogether form a prototype unit of PRI structure. This is further illustrated with a suitable figure in the section below.

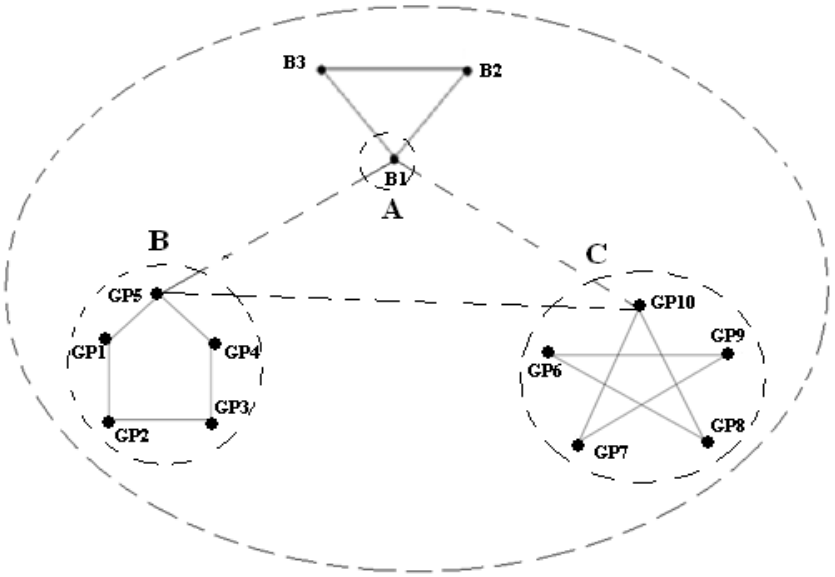


Fig 12: A connection of blocks and GPs where A, B and C are taken as separate nodes.

7. Use of Graph Models in PRI System:

The main objectives of the present study are to find out the basic indicators to measure the severity of backwardness, to calculate the procedure for weighting or aggregating for reducing to a single measure, to find out the cut-off point below which areas are to be considered backward, to study the distribution pattern of backwardness areas in India and to find out the basic problem of backward areas and suggestions to reduce the levels backwardness of the districts.

The primary function of PRI in Village, Block and District level governance can be outlined as follows

Mounting draft development plan is the utmost task. PRI play an important role in formulating plan for economic development and social justice. Schemes for economic development and social justice in relation to 29 subjects mentioned in Eleventh Scheduled of the Constitution are also executed by PRI. Not only this but also PRI checks that imposing and collecting taxes, duties, tolls and fees at the appropriate rates are taking place at right time in blocks and the

grampanchayts. Establishment of cottage industries and small scale industries are established at large number. Different and innovative schemes are being applied for improvement of agriculture. Construction and maintenance of roads and bridges are also being taken care in blocks and its consecutive lower level. As discussed in sec 6.1, 6.3 and 6.4 Regular graph and Pascal graph is widely used in establishing the network between the blocks and the lower level. Previously various methods have been implied in this purpose but none appeared to be very effective. But the implementation of these graph models are done for the first time and it proved very effective and efficient from its very first turn.

8. Benefits of Using Graph Models:

This paper analyzes how graph models are being used for the first time in networking the blocks and the grampanchayats in PRI system. The application of the graph models proved quite beneficial. This is completely a whole new approach which is being used. Previously various techniques and methods have been implemented to describe the PRI structure but none have ended up in a good explanation. But the clarification and the analysis that are given in this research work by the two most efficient and effective graph models- the Regular graph and the Pascal graph are very much precise and to the point. As discussed in sec 4. Regular graph is that graph where every node has same no of degree. This property when implemented in PRI system in interconnecting the blocks and the grampanchayats made the network very strong and effectual. The data can be easily transferred from one block to other and also between the grampanchayats. The loss of information while passing from one place to another is almost negligible. Again communication is done in PRI system at ease. Not only this but also if any new blocks came into existence in the due course of time, the new blocks or gram panchayts are connected to the existing model very easily without any hazards or possibility of losing data. Communication is also set up between this new blocks or gram panchyats to upgrade and match its level with the existing model in a proficient way. Structure thus developed using regular graph is very much well structured, strongly connected and well planned. Again as we discussed in section 5.Pascal graph is that graph where every n^{th} node always remain connected with $(n-1)^{th}$ node. Using this property the blocks are connected with the gram panchayts making the model a tighter one. Another important property of Pascal graph is that one of the nodes remains

connected with rest of the nodes in the model. This very property gives a faithful assurance that loss of any sort of data can easily be avoided. Thus like regular graph, Pascal graph also helps in communicating the blocks with the grampanchayats and data are also transferred effortlessly. Thus in a scenario where there is no good method or model or process to describe the structure in PRI system properly the new approach and effort made by the previously mentioned graph models proved quite beneficial. The elaboration and illustration given by these graph models on the pretext of connection of the blocks and the grampanchayats is in an uncomplicated way. Thus its simplicity, efficient and effective properties make it easily accessible to everyone. Further entity relationship diagram and data flow diagram can be made with the analysis of the graph models and thus in turn software project development process can also be initialized from this point.

9. Conclusion:

The main objective of this research work is to establish a strong network between the blocks and the grampanchayats in PRI system. A sincere attempt is being taken to fulfill its goal using two newly introduced model of graph model i.e. Regular graph and Pascal graph. Regular graph with its simple properties provides a good aid in networking in between the blocks and the grampanchayats respectively. The Regular graph has been generated along with some extra details e.g. the degree of particular node and its index. On the other hand Pascal graph also simplifies the task of connecting the blocks with the lower level. Therefore the Pascal graph is at a precise level of reliability. Thus communicating between these units in PRI system is no longer troublesome. As a result of this all the basic sector of PRI system made a good progress towards betterment and modernization. The sectors include from administrative unit, financial, health, wealth to primary education and even higher education.

Reference:

[1] N. Deo and Michael J. Quinn, "Pascal Graphs and their Properties", Fibonacci Quarterly, vol.21, pp. 203-214, 1983.

[2] S. Chatterjee and S. S. Sarma, "In Search of a Versatile and Flexible Graph Model to Implement Computer Network", Proceeding of International Conference on Communications, Devices and Intelligent Systems, pp. 635-638, 2004.

[3] S. S. Sarma and S. K. Bandyopadhyay, "Properties and Generation of Some special Graph", AMSE Review,Vol. II, pp. 7-18, 1989.

[4] N. Deo. Graph Theory with Applications to Engineering and Computer Science. Englewood Cliffs, N.J.: Prentice-Hall, 1974.

[5] F. Harary. "The Determinant of the Adjacency Matrix of a Graph." SIAM, Review 4 (1962):202-10.

[6] C. T. Long. "Pascalfs Triangle Modulo p." The Fibonacci Quarterly 19 (1981):458-63.

[7] W. F. Lunno'n. "The Pascal Matrix." The Fibonacci Quarterly 15 (1977): 201-04.

[8] V. A. Uspenskii. Pascalfs Triangle. Trans, and adapted from the Russian by D.J. Sookne & T. McLarnan. Chicago: University of Chicago Press, 1974.

[9] Yannis M. Ioannides, Random Graphs and Social Networks: An Economics Perspective, http://ideas.repec.org/p/tuf/tuftec/0518.html

[10] http://en.wikipedia.org/wiki/Collaboration_graph

[11] http://en.wikipedia.org/wiki/Social_network_analysis

[12] http://en.wikipedia.org/wiki/Network_science

[13] Sanjay Kumar Pal and Samar Sen Sarma, "Computer Network Topology Design in Limelight of Pascal Graph Property", In the International Journal of Next Generation Network, Vol. 2, No. 1, page: 30 – 35, 2010.

[14] An Algorithm of Topology Design and Routing, In the International Journal of Applied Research on Information technology and Computing, Vol: 1, Issue: 3, pg: 336-343, December 2010.