

**NATIONAL OPEN KNOWLEDGE GRID AND TECHNOLOGY ENHANCED LEARNING
FOR QUALITY HIGHER EDUCATION, POSTGRADUATE EDUCATION AND R&D
– PROPOSED AS A MISSION MODE PROGRAM UNDER THE 11th PLAN**

Submitted as draft Mission Mode National Program to the National Knowledge Commission,
MHRD and Department of Information Technology as working paper for the 11th Plan.

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1. THE NEED FOR INTEGRATED APPROACH TO LEARNING AND OPEN KNOWLEDGE GRID

India's higher education system of universities, colleges and institutions of diverse kinds suffers from several problems. While the number of colleges and quantity of seats have gone up considerably, there is acute shortage of quality teachers, and serious systemic problems like poor postgraduate education, fragmentation of disciplines, lack of quality resources, and learning ambiance and a management approach that is more concerned with administration of the education system than nurturing innovation and quality instructional delivery. Subjects are taught in a 'cookbook-classes-exams-marks' approach concerned with high pass percentages and not with imparting quality education. All the three layers of higher education - the graduate, postgraduate and research level programs are beset with mediocrity, lack of developmental focus, innovation, agility, focus on the future or playing social responsibility role of serving the community. While at least the IITs have shown themselves to be good in teaching and its graduates appear to have done well, there is not even one good institution or university in the second most populous country that figures in the top 100 of the world's ranked institutions.

We need to reinvent our higher education system that is aligned with pedagogic principles, set in innovations driven learning environment, that provides the students real-world competencies and make them productive in employment, entrepreneurship and in life. There are a number of reasons for the sad situation of the poor quality of education and research in the country. Here below we first enlist some of them.

In this proposal we posit a technology enhanced approach driven over a national open knowledge grid that we consider as necessary for both enhancing the quality of higher education and research and one that will serve India attaining a knowledge superpower in

about a decade. We also recommend that this proposal is included as the approach to build the core knowledge infrastructure of the country as part of the 11th Plan.

2. SYSTEMIC PROBLEMS IN INDIA'S HIGHER EDUCATION

One major aim of this proposal is to address how we induct technology assisted collaborative system of education across colleges and premier institutions to enhance the quality of education very substantially in the country's numerous colleges and universities. To appreciate how we go about the same, we need to first understand why our present system of higher education is not effective. Here below we list some of the problems faced by our higher education and research institutions.

- (i) It essentially produces and nurtures mediocrity and is unable to cope with fast paced developments in science, technology, industry, commerce and society.
- (ii) Industry complains that most of the graduates coming out of the colleges lack essential behavioral training, understanding basic concepts and minimal proficiency in the skill-sets associated with the subjects.
- (iii) Rapid opening of large number of colleges, particularly engineering colleges has resulted in severe acute shortage of quality teachers in the colleges. Less than 10% of the teachers in these colleges have relevant background experience and articulation skills to deal with the subject. There is not enough concomitant investment in grooming teachers.
- (iv) Good teachers often complain of their inability to bring innovation in their teaching as they are not given the autonomy to both teach and evaluate. They also complain that the management frowns on innovation because if they didn't teach 'cook-book - coaching classes' style, the pass percentage would come down. The present style of affiliate university - college, or the technical university systems is largely indifferent to the needs of good teachers.
- (v) There is no support systems for teachers as there are hardly any peers or senior Professors who act as exemplars and guides to younger faculty.
- (vi) The present assessment and accreditation structures under the UGC, AICTE and other bodies are essentially passive and carry no teeth in the form of enabling provisions like guiding investments and establishing support systems for colleges or their teachers.
- (vii) The present vertically fragmented system of education like postgraduate and/or R&D

institutions separated from undergraduate institutions has resulted in not giving the postgraduates the opportunities of getting exposed in teaching engagements as is the custom in any good institution. This (not merely salary compared with industry) combined with lack of quality educational ambiance and freedom to grow and develop in the colleges keep good persons away from taking up teaching and research as a worthwhile vocation and profession.

- (viii) The postgraduate programs in most universities are in shambles with courses at Masters and M.Tech. Level offered without PhD qualified faculty. In some colleges postgraduate students even go for tuition. The number of good PhDs generated is abysmally low compared to what is required in the education sector alone. Doing PhD is no longer considered a rewarding exercise.
- (ix) Our R&D suffers as there are very few postgraduates graduating with adequate concepts and skills needed to take up the kind of sophisticated R&D projects in the various R&D organizations and industry. R&D institutions like those under CSIR, ICAR and such others function in near isolation from postgraduate education and academic research. The result is both
- (x) The colleges and universities are resource-poor. Though they may have internet, LAN and systems, they don't have the capacity to maintain sophisticated systems and services, digital library, e-publications, computing facilities, etc.
- (xi) Students and teachers are hardly aware of current trends, study leading scientific literature and journals, industry and professional literature, activities of professional societies, etc.
- (xii) Industries are yet to get involved in any significant measure to help the colleges or improve higher education. Partly this is due to lack of avenues for them to participate.
- (xiii) The average student in many of the colleges is brighter than the average teacher. They do not get teachers in some of the subjects. With classmates, social and tuition support they somehow manage to self-learn and answer questions to pass the examinations. But they get very little exposure to state-of-the-art developments in the subjects.
- (xiv) Most management of the colleges have little clue on how to build and run good educational programs. They and the affiliating universities are circumspect about breaking the present vicious circle of syllabus - classes - exams - pass percentage syndrome.

(xv) Most colleges function in a 9am-to-5pm syndrome. We do not see students using libraries, doing serious computing, discussing subjects in the corridors or teachers arguing with students on subject matters, or events held on current developments in the subjects. Not many quality seminars or workshops to expose the teachers and students to current state-of-the-art. The intangible factor called learning ambiance is sadly missing.

(xvi) The overemphasis on marks in the university exams and making it a major determinant for placement opportunities from the large number of lesser known colleges gives little room for giving weight through valuation of learning activities. There is a need to redesign the evaluation processes that reflect the capacity of the student to comprehend the real-world understanding of the subject.

(xvii) In the present 'cookbook education', we fail to impart practical training of relevance, capacity to observe real world problems and abstract the issues from it in the models that we teach them in the subject and apply what we learn to address the real world issues. Learning each subject in isolation, the students fail to develop

The three or four years a student studies in a college are largely wasted in getting coached to answer cook-book oriented teaching and examinations. To compound these problems, the system of universities and affiliate colleges have no clue or capacity to address the above problems on their own. They are more caught in a cycle of admissions, exams, quotas and such issues and unable to address teaching - learning related issues. **We may note that quality education is more about how we teach and impart learning, not so much about the syllabus that mentions what to teach.** Whatever goes on as continuing education for teachers are mostly done in a casual manner with little enthusiasm on the participants to study further in the area.

The cost to the country due to the poor quality of education offered in the existing educational system to the country is far too high to be acceptable. This has led to a shortage of competent scientists, technologists, thought leaders and professionals amidst the plenty of bright young minds that our country naturally has. We are also weak in organizing and mobilizing our Science and Technology (S&T) for the national good. As a country, we neither have the focus nor strategies to develop with realizable objectives. In most cases we follow developments in science elsewhere, not build the country's leadership (even in our traditional philosophical systems) in any specific domain. Our S&T developments are more 'reverse engineered' to achieve some strategic areas and not building global leadership in

strategic domains of national importance.

3. SYSTEMIC PROBLEMS IN NATIONAL SCIENCE AND TECHNOLOGY LEADERSHIP

Our country's S&T grew in three broad directions. First are the nationally strategic areas of developments like those under the Atomic Energy, Space, Defense and such areas. Generally these received generous funding and meet to some extent our strategic needs. However they do not work adequately closely with 'outside' institutions, particularly boosting education and research in basic sciences, technology and management that is crucial for the steady supply of high quality manpower for their future needs. In some areas, we do not have a clear root institution to undertake the leadership. There are some exceptions to this. We may cite the example of the LCA Project. Here we set up a mission mode approach involving a large number of defense, industry (both public and private) and academic institutions coordinated by a nodal Aeronautical Development Agency. The second set of research was built in the Nehruvian model of specialized labs like those under the CSIR, ICAR and the different departments of the government. The shortage of quality scientific manpower and lack of capacity for taking up strategically important complex interdisciplinary research programs has and of national relevance has made them achieve much below their potential. Again they have functioned in isolation from the academic institutions and universities with many of their highly qualified scientists not available to groom young minds in the colleges. This has been a major loss as today we find that science education has become very weak and not many bright students opt for it.

Because of the fragmentation with little communication in R&D across the numerous S&T labs, we have never built national leadership of global standing in any area. Our R&D initiatives have weak linkages to both academia and industry. Mostly, these R&D institutions are not part of any significant national strategic initiatives. Here we show an example of the area of scientific computing and supercomputing. A CDAC was established for promoting advanced computing. It deals with mostly providing raw supercomputing power from commercially bought and assembled parallel computing facility under the PARAM program. This initiative by itself is unable to make any significant dent in competency building in the area. There was no clear national leadership strategy in the area. The universities and colleges were hardly involved in introducing courses and research in High Performance Computing, Algorithms, Optimizing Compilers and applications development. There were other fragmented initiatives like the Flosolver at NAL that has made significant contributions,

the ANURAG and such others. But they don't work closely with CDAC. The IITs and IISc went ahead with installing their own cluster computers and 'supercomputers' for their own studies and research. There was the Supercomputing Education and Research Centre at IISc that functioned in isolation from the rest. Competency and capacity building in this area can not be complete without establishing similar capacity building in major national open scientific databases. Now there is the Garuda grid project trying to link users of supercomputers. Its scope is narrowly focused to connectivity and not the more strategically important need of competency and capacity building in the subject area. The result is that today we are yet to see any significant national focus in developing this strategically important area. **William Press, the author of 'Numerical recipes in C' says that, "Simulation and Mathematical Modeling will drive the 21st century just the way steam did in the 19th century."** In such a strategic area where we have the potential to achieve global leadership with mostly educational, intellectual and computing efforts, we are nowhere a significant player internationally because the different initiatives are in fragments and they are also mostly decoupled from the undergraduate education in Mathematics, Physical Sciences, Chemistry, material sciences, Biological/Life Sciences and Signal Processing. There are hardly vertical linkages between college, postgraduate, R&D and high-tech industry sectors with clear national strategy focus in any major area of significance to national leadership and economy.

Scenarios like the above are frequent in many fields of education and R&D. Such scenarios arise because the government funds mostly capital acquisitions by way of hardware, instruments and does very little in either providing strategy focus or corresponding competency/capacity building among the young people in the colleges. This isolation of R&D with strategic implications from the universities and colleges has also resulted in the education offered to our young scholars becoming outdated.

Hence, reviving S&T has to go hand-in-hand with capacity building and quality higher education. **The proposed framework of National Open Knowledge Grid combined with Technology Enhanced Learning will break this impasse and give strategy focused development a major thrust.** This allows for the necessary interdisciplinary approach across relevant multiple institutions, industry and organizations that is needed to achieve the results in the emerging knowledge driven economy.

3. WHAT IS THE NATIONAL OPEN KNOWLEDGE GRID?

The proposed National Open Knowledge Grid is will functionally interconnect institutions, universities, colleges and R&D organizations over broadband networks in a disciplined manner and in ways that support specific Information - Interaction - Collaboration services by a mix of members from the different concerned organizations. Until recently, most IT services were driven by client-server architectures. Unlike the client - server architecture, Grids are built over peer-to-peer interconnections across systems in different institutions at services level.

Over the last few years, the world of IT is steadily shifting to enterprise systems built as n-tier architecture over middleware (like Tomcat, Apache, Websphere, Weblogic, Pramati, dotNet, etc.). The middleware in turn governs the access to several servers in geographically distributed places hosting services like specific databases, email, computing, and numerous enterprise applications. There are several Grid applications that work across systems distributed in different organizations, or within a given organization. The services Grid offers may be built using datagrids, computational grids, information sharing grid, virtual collaboration spaces across multiple organizations and so on. The National Open Knowledge Grid is built as a Grid of several functions specific grids spanning different groups of relevant organizations. A figurative illustration of the Grid is shown in Fig. 1 below.

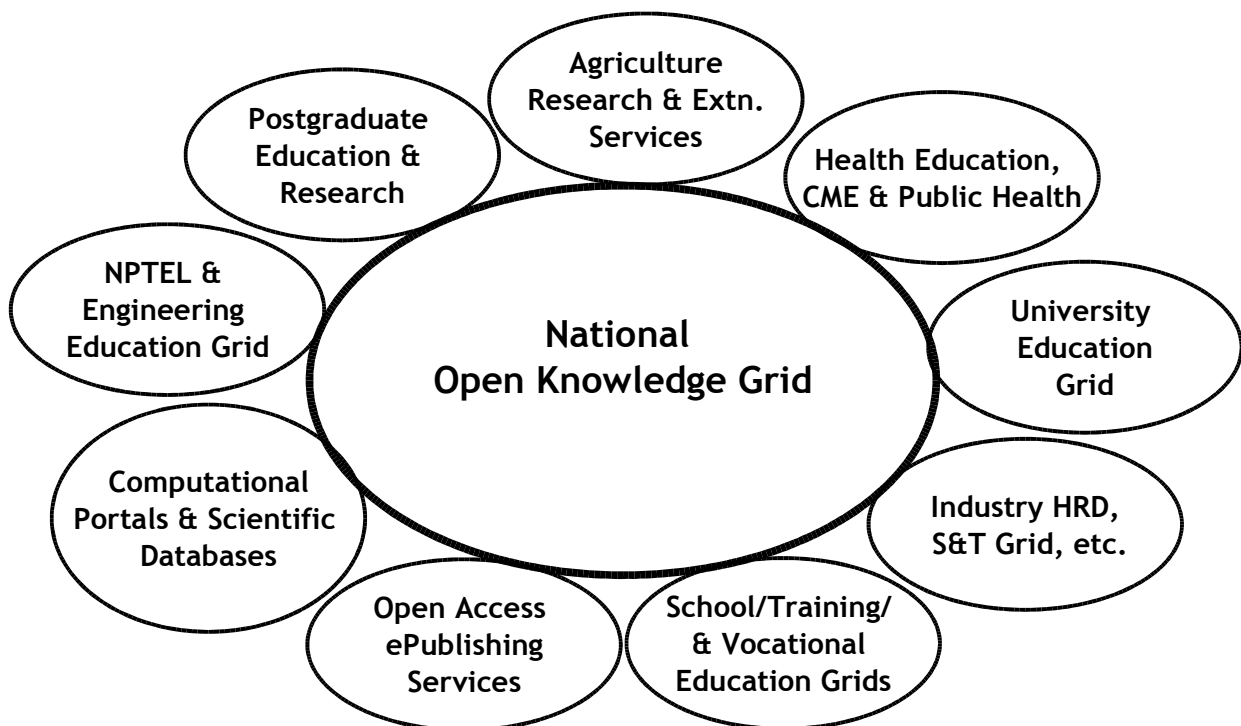


Fig. 1: NOKG as the core Grid that supports other area specific Grids

Grids are a disciplined way of providing ICT facilitated services over loosely connected (but secure) systems that are geographically spread out in diverse organizations. **Grids allow for different component services of value joining with other organizations and support Thematic, or Virtual Communities or Enterprises with members from different organizations supporting the services.**

At IIITM-K we already have several portals like its KISSAN-Kerala, Kerala Education Grid, Computational Chemistry Portals, Virtual University for Agricultural Trade, Police Portal for Community Interaction and the Institute Portal that conform to open services oriented architectures are grid compliant. IIITMK has also guided establishing such portals and enterprise integration systems for many leading organizations like the NAL, ISRO, ADA, Wipro, TCS, Ashok Leyland, etc. In USA and advanced countries several grids are already functioning. Realizing the need to standardize these developments, the Open Knowledge Initiative (visit www.okiproject.org) supported by leading universities and industries is coming out with the requisite standards for services oriented architectures. Leading industries like IBM, Sun, Oracle, Microsoft and others are supporting these developments and also redefining their applications and services in compliance with this emerging scenario.

In India, there is little systematic work going on in ensuring applications and services over networks are grid-compliant. **The most significant advantage of Grid supported services development is that it largely decouples to a large extent the issues of developing technologies and systems that support components of ICT facilitation from that of developing and maintaining services of value to the society and different target communities.** The development of services supporting Grids is hampered largely due to the lack of adequate interest in taking up services oriented IT developments in premier institutions like the IITs and leading organizations or universities. Often such services are usually supported by organizations other than those that develop the systems themselves. This will no longer be tenable as it hinders the growth of ICT itself in the country. Also our country's IT developments in Education, E-Governance and other fields are yet to take cognizance of the need for establishing a grid based framework. Education and R&D in this area is largely brushed under the web-technologies as the subject area, even though it involves all disciplines in the Computer Sciences and Informatics areas and there are many deep concepts and systems that go into its constituents like the datagrid, computational grids, information systems organization, semantic web, web communities, logistics management and many such others.

Google, Wikipedia and similar developments are examples of the kind of services one may build over open knowledge grids. Hence the systematic development and nurturing of the emerging system of grids, web communities and virtual enterprises has to be taken up on priority. Without the initiatives in establishing and managing the grid framework in ways that unify the ICT developments, serious IT applications in socially relevant sectors, S&T and many strategically important areas will be a slow and painful process. Services Grids of different kinds will become the routine in the coming years. This is borne out by the experience of IIITM-K in implementing several useful grid based services through its agricultural portal, the computational chemistry portal and such others.

Here we may briefly summarize the services frameworks enabled by the National Open Knowledge Grid.

(i) The services support framework for Virtual Enterprises and Web Communities

As an example, let us take some sample web communities for supporting services. The first may be a set of experienced academicians (say 2 or 3 of them) mentoring a virtual community of teachers in a specific subject, e.g., Electromagnetics. The expert mentors use a portal that links to different component services to support the teachers. These may be the discussion forums in the subject, the links to learning materials, refereeing a subject specific Wiki for building authentic content, conducting open support and certification services for teachers in the colleges who are assigned to teach this subject, posting open problems and study materials of value to students in the subject, etc.

The second example may be a Virtual R&D Community having a mix of senior scientists, upcoming young scientists, research scholars, postgraduate teachers in the subject area - all from different organizations, institutions and colleges. An example of this is the Computational Chemistry Portal that IIITM-K is continuing to develop and maintain for interested Chemistry teachers and researchers.

A third example may be a portal to support farmers who take up farm loans or credits that assists the farmer at every stage from the planting to post-harvest so that they gain maximally from the loan availed.

All the above examples show the need for virtual communities of experts, academicians and target groups collaborating and working with specific missions and objectives. One of them is to provide high quality education in Electromagnetics, the other to foster and develop the

advanced R&D area of Computational Chemistry and the third to support farmers taking loans. They all have a certain common information-interaction-collaboration-computing framework as illustrated in Fig. 2 that we refer to as the 'Knowledge Services Workgroup Environment' (KSWE).

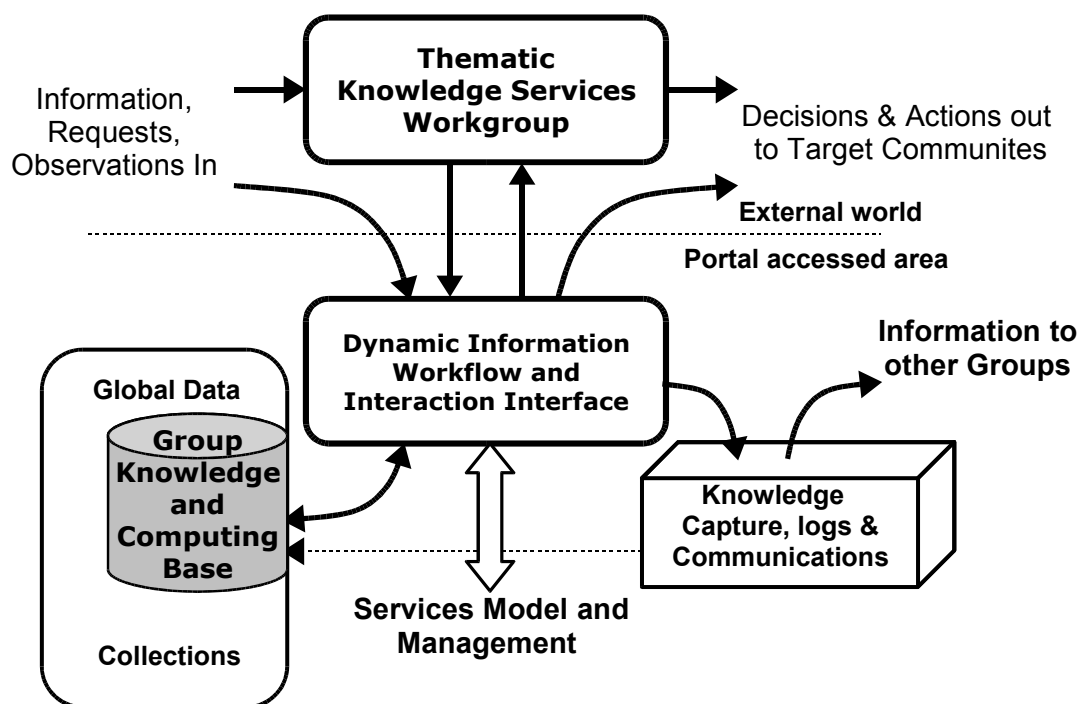


Fig.2: Knowledge Services Workgroup Environment

In Fig. 2, all activities below the dashed line are supported by a distributed collection of servers and systems over a service oriented architecture that are connected over the National Open Knowledge Grid framework. Above the dashed line is the peoples' world of target groups served by the web community, or the thematic knowledge services workgroup. Such coherent web-community driven systems are need state-of-the-art information systems. Globally, the Open Knowledge Initiative (OKI, visit www.okiproject.org) driven by leading universities and IT industries is already evolving the requisite interoperability, security, authentication and such features of relevance for the establishment of open knowledge grids. In a deeper sense, the OKI will be doing to information systems and services what the IETF (Internet Engineering Task Force) did for the development of Internet itself. India is not a significant player at all in the OKI, W3C and such globally important initiatives.

There have been some small initiatives in the country. As an example we have the IITM-K piloting several portals (like the Computational Chemistry Portal www.compchem.in, Education Grid www.edugrid.in, Kerala Agricultural Portal www.kissankerala.net) that

conform to the OKI architectural framework. IT industries ranging from IBM, Sun to Microsoft are now agreeing to such interoperable standards as recommended by the OKI framework.

We recommend that NOKG is established as a natural extension of the present developments in the connectivity and content and push them into services oriented architectures. Over such NOKG, we can establish any number of services specific web-communities as given in Fig. 2 and enable them to offer their services effectively. **The Public Services Delivery paradigm of E-Governance is in fact effective deployment and management of relevant issue centered thematic services communities as abstracted in Fig. 2.**

Establishing the NOKG needs the following layers of implementation.

- i) **Connectivity:** We assume reasonable broadband connectivity across institutions, universities and colleges. This is getting into place as part of the country's telecom developments, SWAN, EDUSAT, Mission 2007 and such initiatives.
- ii) **Content:** There are different kinds of content. Those for educational purposes is getting done by NPTEL, NCERT, diverse academicians putting their content in the open, initiatives like the MIT Open Courseware, the large number of educational television material, etc. However we need also content in the form of scientific databases, e-governance databases, open access publishing, personal information of different kinds. The systems to aggregate and provide such dynamic data over which we can conduct our knowledge driven services of value is best done over the NOKG architectural framework.
- iii) **Information Systems and Services Architecture:** This provides the most crucial skeletal ICT framework for the NOKG architecture. It facilitates all the user groups, their activities related workflow and services framework. There needs to be some degree of consistency across shared resources serviced and maintained by the different parties. The NOKG architecture needs several studies and reference implementation that fall under the broad class of Advanced Informatics. We propose that a National Centre for Advanced Informatics (NCAI) is established as the agency (like the Aeronautical Development Agency of LCA) to coordinate and maintain reference configurations. NCAI will be like an Inter-Institutional R&D and services centre in the development of NOKG just like the Inter University Centres, r more closely play a role like that of ADA in the LCA development.
- iv) **Applications and Services deployment over the NOKG:** Very many number of

applications and services have to be deployed and managed by and for a number of institutions, colleges and universities. Often the colleges themselves have little capacity to establish and maintain advanced IT services. For example most colleges do not have portals that are so essential to manage students' interaction and eLearning. So we have to come up with a different strategy to install applications and establish the services. We suggest the same later in Section 6. Likewise most R&D organizations are not conversant with establishing and running their open access publishing, databases, query management, protecting privacy and confidentiality in workgroups, etc. So we propose a distributed 'Virtual Learning Campus' [1] to establish the NOKG.

v) Promoting Thematic Services Groups and Virtual Enterprises over the NOKG:

Ultimately, real-world issues have to be addressed by experts from multiple organizations. For example, if we want to establish Technology Enhanced Learning in a subject area, different competent academicians and teachers in the subject have to service a common subject-specific portal and interact both among themselves as well as with the large students' body outside also. Similarly, if we wish to establish 'Knowledge Empowerment Services' for better use of farm credit, we need to bring in relevant empowerment community of bank officials, agricultural consultants, relevant experts from the agricultural organizations, the universities and extension services together as a thematic services group.

Here we illustrate the Computational Chemistry Portal of IIITM-K as an example of how a Thematic Services Group functions over the NOKG. The portal is a front end system for users to access different services - like access to databases, choice of computational programs, participate in the blogs of users, coordinate events like workshops and seminars, access relevant journals and open publishing, facilitate technology enhanced learning of key subjects in the area, etc. There are experts from different institutions and universities who coordinate the services offered by the portal. The different backend services accessed through this portal may be served by systems and servers located in different places. The example of how a single Computational Chemistry Portal [2] set over an NOKG as is being already run by the IIITM-K is illustrated in Fig. 3.

What we illustrate here is the way future ICT systems are going to support services of diverse kinds. Through portals, virtual communities of relevant experts and services providers bring together the different component services providing focused support to the different

components relevant (ontologically close) services that make them very effective. In today's Internet facilitated some of such components are serviced by different parties without coordination among themselves, nor really addressing the target community of the service. With the NOKG and the proposed approach the services will be centered around the target community and its needs.

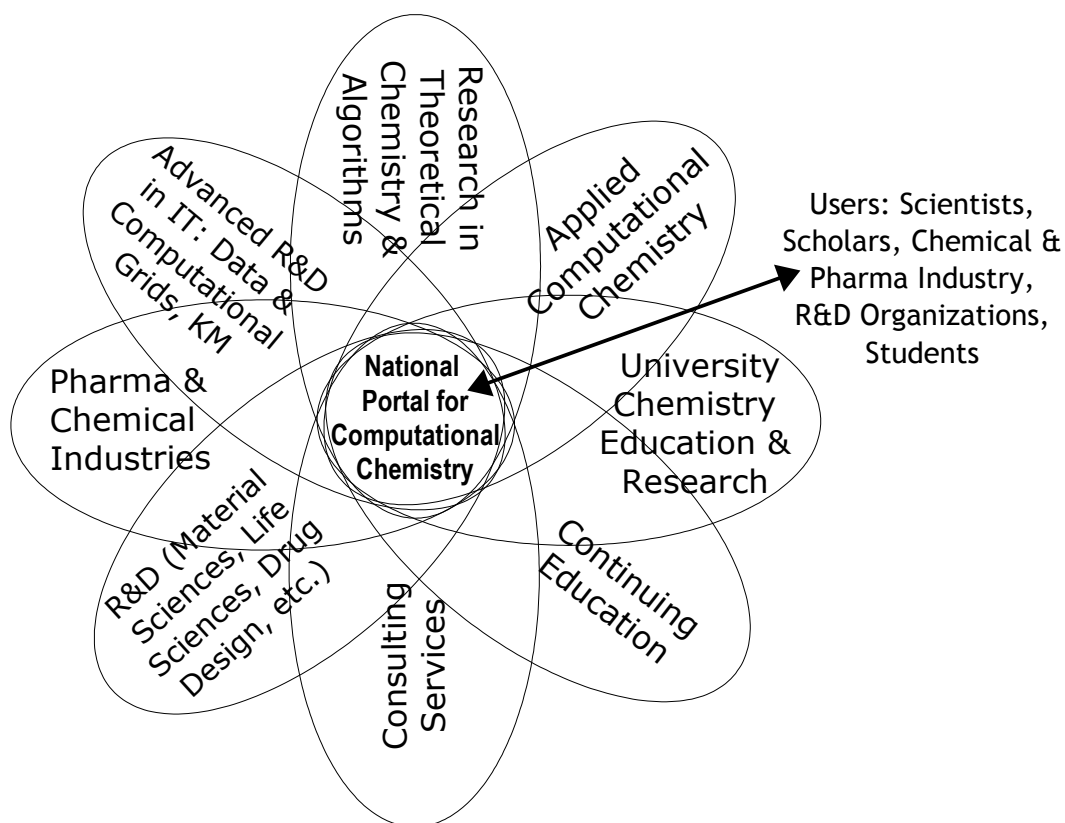


Fig. 3: National Portal for Computational Chemistry as Example of Services Over NOKG

We may provide any number of scenarios like the one illustrated by the Computational Chemistry Portal for servicing the thousands of target communities over the NOKG. Next we show how we go about building the NOKG under a National Mission Mode Program of the 11th Plan. Then we show how the NOKG supporting the Education Grid methodologies and content from sources like the NPTEL will overcome the present difficult issue fo providing 'Quality Education to All Independent of Geography'.

4. BUILDING THE NATIONAL OPEN KNOWLEDGE GRID

Building the NOKG and enabling the multitude of collective knowledge driven services for diverse target communities calls for effective coordination and action at the various levels enunciated in the previous section. The present approach of fragmented initiatives like establishing SWAN, automation of citizen services in e-Governance in the name of G2C, G2B, G2G, or IT enabled educational services, etc. have to be redefined and realigned with clear focus on total services focused on the issues to be addressed for target communities by the coming together of the different parties over the NOKG in ways that adds much value to the services. Here we bring out the complexity and also the approach to establish the NOKG in ways that bring true knowledge driven services possible.

In knowledge driven economic or empowerment activities, education, decision support, action at the field levels go together. Every thematic services community will have to practice the five principles of information services as explained in [4]. Such capabilities are naturally supported over the NOKG framework. Here we illustrate the set of issues and activities that have to be addressed.

4.1. Tackling Complexity of Systems in NOKG through a National Mission Mode Program

Here we reiterate the complexity of the systems as outlined earlier in [1]. **Every knowledge driven institution, or R&D organization has to deal with maintaining a kaleidoscope of interdependent services as illustrated in Fig. 4.** The figure illustrates some of the important systems and services needed in today's education and research. All these complex systems need to be developed, continuously updated and maintained for the large number of user communities. This requires that the current approaches to connectivity and content has to be enhanced to establishing and maintaining the system of complex services ranging from Learning Management Systems, Campus ERP, Digital Library to Open Access Publications and Computational Portals. Unless these are professionally managed, the support needed for managing Technology Enhanced Learning and Teaching (TELT), or, the Knowledge Empowerment (KE) services that we wish to offer will be very weak. **We have to bring all domain-rich institutions like those in Higher Education, R&D, Agriculture, Health and Professional Education together and equip them over the NOKG to participate in the thematic group services to diverse target communities.** Even premier institutions like the IITs and IISc can play only a small role in professionally managing and servicing the information systems, computing resources and domain related services.

Hence we need a different approach. We establish the NOKG as the services support for these Technology Enhanced Learning and Teaching (TELT) and Knowledge Empowerment (KE) services. We may note that our IT industries are yet to grow from a tender - contract project execution model to managing advanced value added public services of value. There are many areas in the NOKG that do not fall strictly within the services ownership of existing institutions, universities, colleges, R&D, government or industry. This calls for and justifies the launch of a National Mission Mode Program to establish the NOKG and serve the needs of higher education, research and knowledge empowerment services. The program has to be managed under an open professional framework wherein the different layers are serviced by different relevant agencies or institutions.

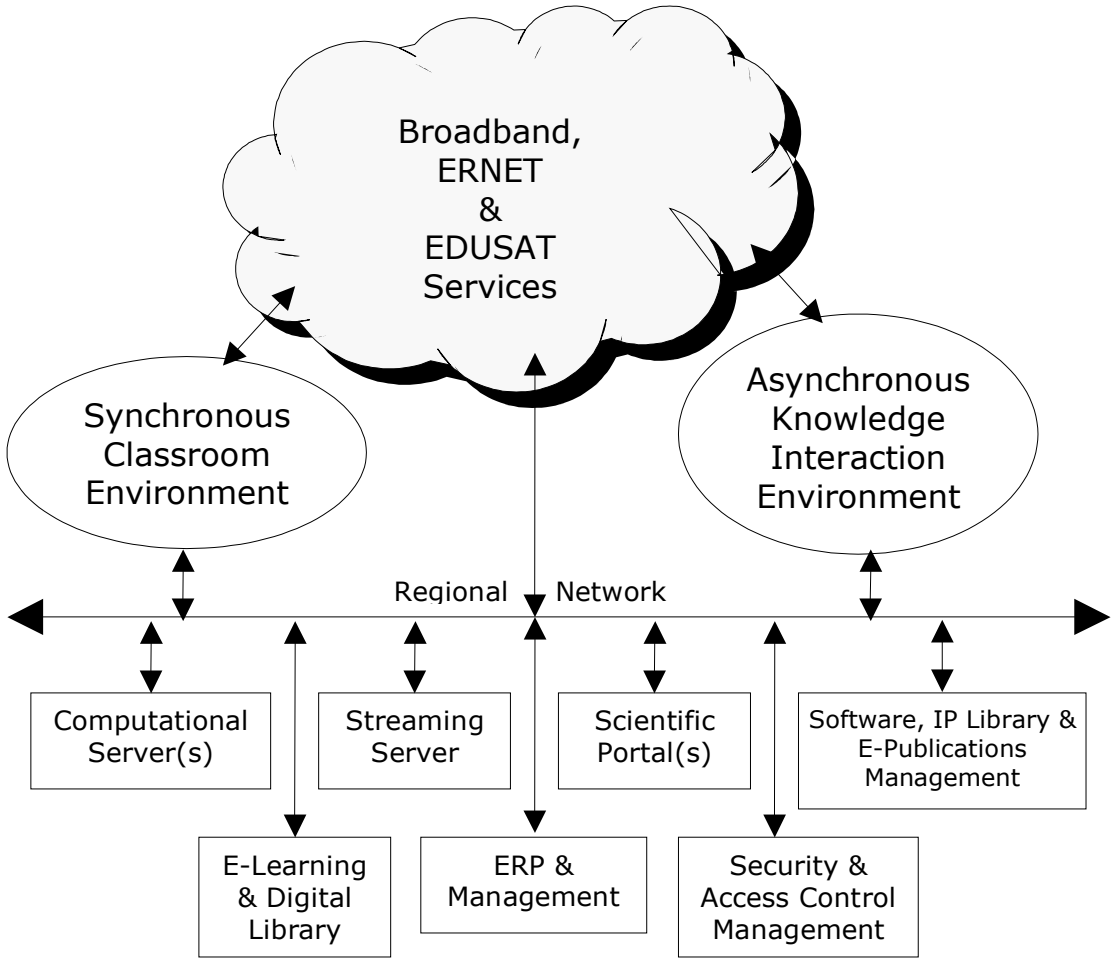


Fig. 4: Future Information Infrastructure for Education

We observe that NOKG and services supported over it need different kind of enterprise driven approach to establish and serve. In the coming years where the diverse institutions will both give and take many sophisticated advanced IT enabled services. To make this happen

efficiently and encourage the coming up of large number of knowledge enterprises, the NOKG will have to be established and managed in an open framework. Different institutions, organizations, open developers and industry have to build the different component systems deploy them wherever they decide to serve and get integrated into the NOKG.

4.2. SERVICES AND DEVELOPMENT PERSPECTIVE OF THE NOKG

In Fig. 5, we show how a developer, teacher, scholar or services provider (like a thematic R&D group) may look at the NOKG. It illustrates the functional view of NOKG as the Virtual Learning Campus (VLC). The VLC supports near-total open learning and knowledge related work environment for all concerned. We may include Human Resources Development sections of every industry, R&D organizations and major publishing and database aggregators as part of the VLC. We may have several VLCs across the country as the different component grids and bring them together as the NOKG as illustrated in Fig. 1.

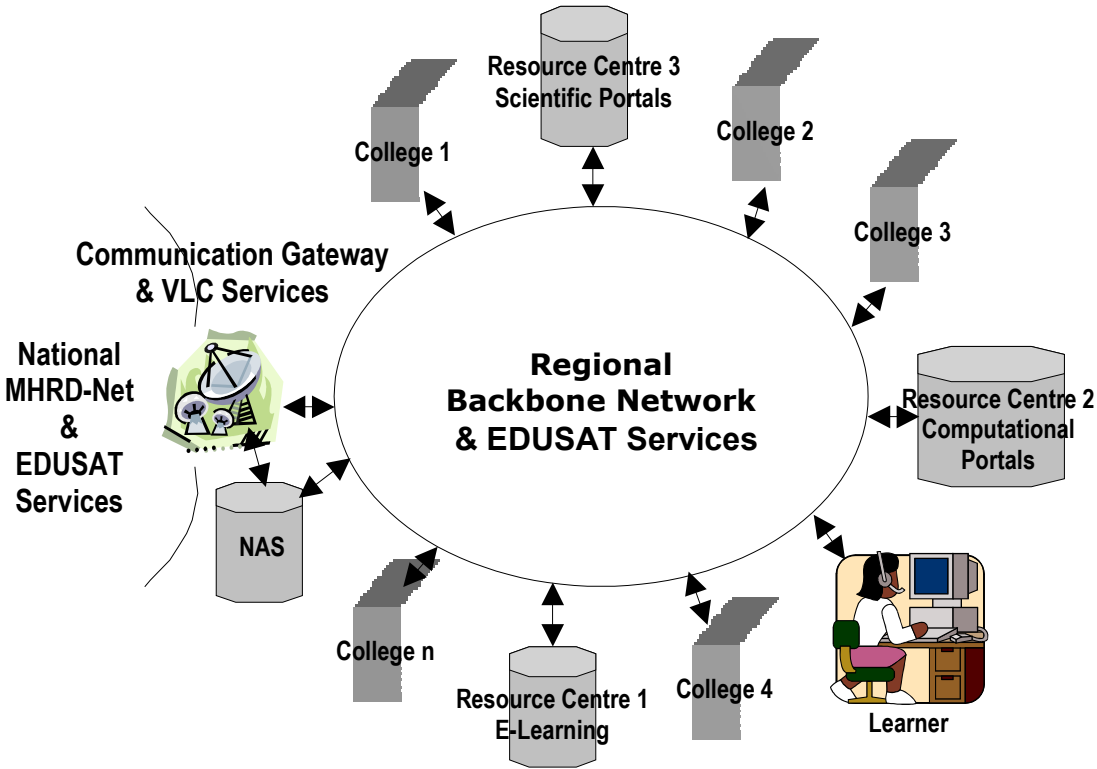


Fig. 5: NOKG Virtual Learning Campus

Here, for example, a scholar may get e-learning- say on statistical modeling and simulation in economics, get necessary data and information from a scientific portal maintained by an Agricultural University, do a simulation and forecasting using suitable algorithms and

programs from a Computational Portal made available for the purpose - all these done without the scholar's college (say an Arts and Commerce College) necessarily possessing anything. To make this happen we need to establish facilities managed by relevant experts and academicians in different institutions in the different subject or services domains. The systems to support it may be in the institution, or, located in well-maintained data centres. The SWAN data centres being established with new social enterprises models may establish and service the NOKG's VLC systems and services.

5. NATIONAL MISSION MODE PROGRAM TO ESTABLISH AND SERVICE THE NOKG

The present approaches in establishing IT services are too fragmented to bring out the synergy through inter-institutional and interdisciplinary collaborations that are necessary in thematic groups and virtual enterprises knowledge driven services. It is important to appreciate that unless we get our acts together and build the coherence across the diverse national (but today's fragmented) initiatives like the ERNET, SWAN, EDUSAT, AGRISNET, Mission-2007, Education Grid, diverse E-Governance projects, etc.

Just as we successfully launched space missions, and aerospace developments like the LCA developments in mission mode, the most important need for the country is to launch a mission mode plan to rejuvenate our entire higher education sector and bring better coherence in R&D to support our strategic developments. **We may repeat here the oft quoted vision of Vikram Sarabhai, “.. If we are to play a meaningful role in the community of nations, we shall be second to none in the applications of advanced technologies to the real problems of man and society.”** It is becoming clear that advanced technologies are to address the real problems of the man and society, we have to establish the base on which the relevant services will be executed. In the emerging networked society, NOKG will form the base for the knowledge infrastructure for the entire country.

5.1. Why a Mission Mode Approach?

NOKG as the knowledge infrastructure involves the coming together of multitude of institutions offering hundreds of services through collaborating communities. In our country's experience, programs involving multiple institutions never got managed well unless we create some kind of mission mode structure. As an example we had the LCA project hanging without

achieving much till the mid 80s, even though reasonable competent institutions and industry existed. It was then we established the Aeronautical Development Agency (ADA) to put together a multi-institutional - multi-site development program and then we go the LCA moving ahead. Likewise we propose that the NOKG is established as Mission Mode Program for the entire country - possibly under the Dept. of Space (like ADA under the DRDO) as the neutral department and one that is dedicated to driving the vision of Vikram Sarabhai. The NOKG at the ground level will complement both the Satellite infrastructure under DOS and the growing Broadband Internet infrastructure on the ground. The mission mode model of ADA is best adapted to establish the NOKG along the lines given in the next section.

6. ESTABLISHING THE NOKG AS A NATIONAL MISSION

Our goal is to establish a nationally coordinated mission that establishes the NOKG to support the numerous knowledge driven services needed in sectors like Education Agriculture, Health, eGovernance, R&D, and SMEs that are crucial to accelerating the pace of development. There exist no existing agency or departments in the Government that understand the span of disciplines and technological competence needed to establish and service the NOKG. The IITs and other existing premier institutions, the universities, while no doubt will provide their 'extension' services and open distributed learning over the NOKG, it requires a 'neutral' coordinating agency to develop, establish and service the diverse constituent systems that go into it. We propose to follow the ADA type Mission Mode NOKG Program model.

We propose the establishment of the National Centre for Advanced Informatics (NCAI) as the central agency for the NOKG Mission Program. NCAI will be equally close to (not equidistant from!) the different stakeholders of the NOKG. NCAI will be managed as an advanced inter-institutional research, development, deployment, training and referral centre for establishing and commissioning the multitude of systems indicated in Figs. 4 and 5.

6.1. The Role of the NCAI

If we take the earlier example of the Light Combat Aircraft, the project has large number of developmental, testing and integration activities being executed in almost 100 different organizations. Likewise, there are a large number of activity areas related to building the NOKG and commissioning services over it. Much of the legacy portals and services currently

on will also be made compatible with the services oriented architecture of the NOKG. They include information systems, Indian profiling of relevant IT and Information Systems relate standards, several technologies, competency building programs, awareness campaigns, working with industry, government, R&D organizations, universities and institutions, promotion of postgraduate education and research and nurturing different thematic communities that provide the services. Every thematic community service has two sides for its services delivery. One side is the backdrop of systems and services configured as suited to the thematic community and secondly ensuring that the various ICT functions it needs to reach out to its target community are healthily maintained.

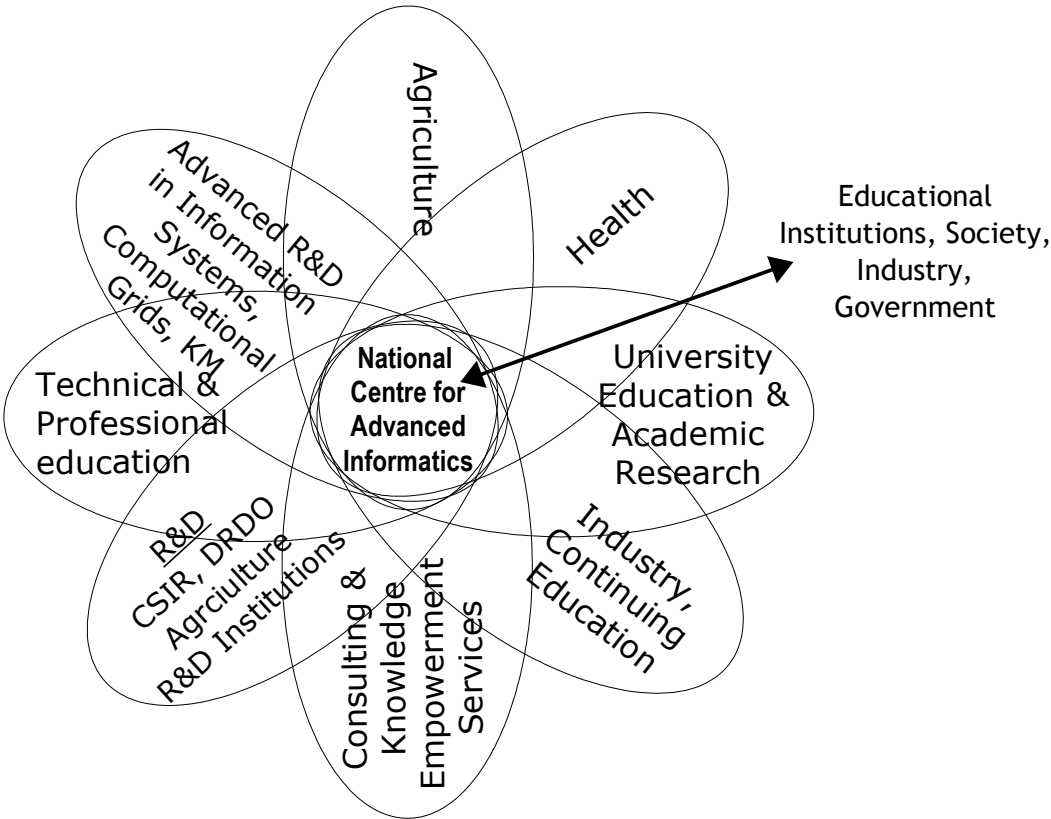
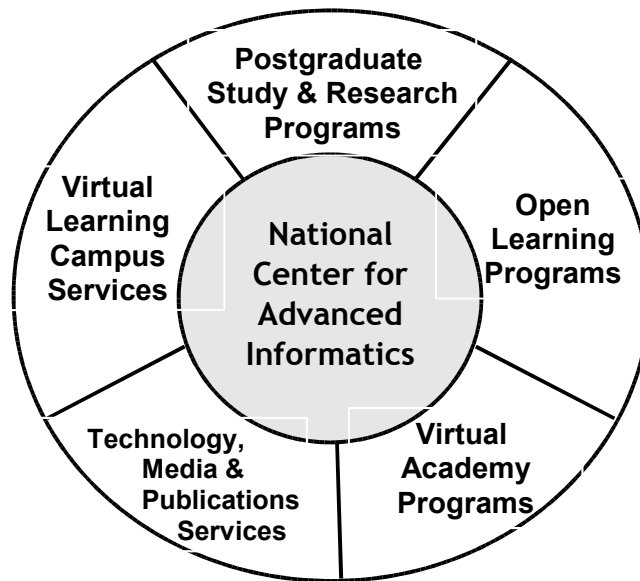


Fig. 6: National Open Knowledge Grid and its Stakeholders

We propose that the NCAI is established as the Mission Mode implementation agency of the NOKG as illustrated in Fig. 7.

At its core NCAI will have a Data centre and a referral Advanced Informatics Laboratory that is essential to testbed and maintain version controlled systems and configuration that are deployed in the different places. It will run an NOKG Coordination Portal for information on all ongoing programs, projects and services. A number of R&D issues will crop up like

development of necessary taxonomies for different information bases, metadata frameworks, open source software development support, etc. We need to have highly qualified scientists and technical professionals associated with the developments and services.



**Fig. 7: NCAI at the center of NOKG
– A Functional View**

The functions of the NOKG are aptly captured in the following Education Grid's Vision Statement: **“Enable, Educate and Empower Every Citizen and Community Through Knowledge.”** In the next section, we briefly explain the role of the NCAI in the context of rejuvenating our higher education and research.

7. OBJECTIVES AND FUNCTIONS OF OF THE NCAI

NCAI will be established as an Inter-Institutional Center (a combination of ADA and inter-university center like the IUCAA) that has core scientists, faculty and professionals, with postgraduate study and research programs in the areas of (i) Computational Sciences, (ii) Information Systems and Sciences, (iii) Applied Informatics in different domains and (iv) Humanities and Management. Today, there are no premier institutions promoting the NCAI must build the the kind of competencies needed in the above areas in ways that promotes the NOKG objectives. As a mission coordinating centre of excellence it will (i) generate postgraduate scholars and research graduates in advanced informatics and its applications in different domains both in its premises and in open distribute learning mode, and (ii) equip the different action areas of NOKG to develop, master and service the necessary advanced

information systems and services.

Coming years will see explosive growth in the uses and applications of advanced information systems, knowledge organization and management in every kind of organization. The emerging broadband and satellite network services will make them widely accessible over the Web, thereby spawning virtual enterprises, virtual universities and learning campuses and such other collaborative programs and organizations in diverse fields and across domains. Presently, institutions of higher learning are weak in the servicing and management of advanced information systems, virtual labs, or, scientific and computational portals. In the coming years, these systems and the broadband network across institutions will form the bedrock infrastructure of education. Even well endowed premier institutions like the IITs, IIMs and almost all R&D institutions in the country today are weak in building and managing these systems. Without such systems well managed and in place, the drag on India's scientific research and progress will continue due to the lack of access to validated Indian data relevant for our developments and planning needs.

NCAI will address capacity building in this area through its in-house and collaborative R&D and postgraduate study and research through the NOKG. The need for the services of advanced information and scientific portals is even greater to offer knowledge empowerment programs under the Virtual Academy programs of the NOKG. Concurrently NCAI will enable the premier institutions in all subjects and fields build their capacity to build and serve such systems and make them available over the VLC for their in house and the diverse open learning programs facilitated by the NCAI.

Thus NCAI, besides building capacity of the NOKG, will also serve as inter-institutional centre of excellence in advanced informatics. It will build the relevant competencies and nurture the culture of sharing and caring through effective knowledge management practices in and across our institutions for maximum benefit to the State's and country's development. The subjects lying underneath this area of basic and applied information informatics is vast and complex with large future scope for advanced study and research. Hence NCAI will itself emerge as a significant premier institution over time.

The following steps are involved in building the NCAI and the NOKG.

- i) Guide the connectivity across institutions of higher education, research, colleges and universities in all subjects and fields in a given geographic region over appropriate mix of terrestrial broadband and satellite networks.

- ii) Set up a Gateway Centre at the proposed NCAI. This centre will be a root node for the regional terrestrial broadband network. Help establish similar gateway centers in the different regions. It will also host necessary facilities associated with ERNET PoP and ISRO EDUSAT or other thematic satellites informatics services hub.
- iii) The Gateway Center will have content development facilities, data centers and portals hosting for the different institutions and supporting Knowledge Intensive Products and Services [KIPS] for the region and outside. It will have Media development for educational TV programs with uplinking facilities over the Edusat. Gateway centres will support research scholars, teacher training and servicing of e-learning, digital libraries and e-publications services for all the member institutions in the VLC.
- iv) Help establish a number of thematic and subject specific eLearning services portals for supporting contents from sources such as the NPTEL with moderated collaboration forums.
- v) Formulate and deploy a number of thematic portals like the one in Computational Chemistry or Agriculture in a large number of educational and economic development relevance that provide knowledge empowerment services to specific target communities.
- vi) Establish **Community Knowledge Exchanges (CKE)**- Datacenters in every district linked to backhaul SWAN in every state. These CKEs will serve all the colleges and educational institutions in the district. They will also serve as local content development and maintenance centers, as extensions to reach advanced technology enhanced learning support. With the CKEs, the Mission 2007 dream of 'Every Village A Knowledge Center' will become a reality. The CKEs will act as pooling centers of Informatics services to all the colleges in the district. The colleges need not own advanced systems or need to have recruit tech savvy professionals to run these services.

The proposed NCAI and NOKG approach will integrate several of the ongoing and proposed network initiatives in the country. All our institutions of higher learning, research and services organizations in every sector need to master the intricacies of working in a knowledge driven world. To build this culture, NCAI will have programs to nurture organizational learning for institutions of higher learning and R&D at every level and in every

function of today's institutions. NCAI and the NOKG will play a catalytic and constructive role in equipping our institutions of higher learning with the necessary systems, processes and training to assimilate the benefits of TELT.

A major goal of NCAI is to undertake coherent initiatives in the country to develop and establish information and knowledge networks to support 'Knowledge Intensive Products and Services' [KIPS] in ways that will bring out the synergy across institutions and maximize the return on investment. **With proper coherence, such information and knowledge networks will support KIPS on a wide scale, creating large-scale quality employment in socially and economically relevant domains like Education, Agriculture, Health, Rural Development and similar areas.** We expect that NCAI and the NOKG will make much spoken 'Knowledge Revolution' a reality and create knowledge enterprises of social and developmental relevance. IIITM-K today has some experience in this direction based upon the spirit and experience of the its ongoing projects - the Kerala Education Grid and the Kissan Information Systems, Services and Networking (KISSAN - Kerala) that are currently running in Kerala.

7.1. SUMMARY OF THE ROLE AND FUNCTIONS OF NCAI

NCAI will serve as advanced **Inter-Institutional Centre** for postgraduate study, research, mission mode R&D and services in basic and applied information systems, sciences, technology and management. The broad objectives and roles of NCAI are given below.

- i) It will be an advanced technology, mission mode R&D and services institution that connects and serves existing universities, colleges and institutions of education and research **in all relevant subjects and fields** through the VLC network, concepts and NOKG programs.
- ii) **NCAI will host diverse forums and portal based services for the development and maintenance of draft reference standards and national profiles** in e-learning, scientific information systems, e-governance and related open source software libraries.
- iii) **It will serve as the development, standards and deployment test bed for current and emerging information systems, knowledge management services, information, data, computational and education grids in different domains and similar other activities under the proposed VLC.**

- iv) It will host a Gateway Centre of the NOKG. The aim of the NOKG is to facilitate our Institutions of higher learning and research to benefit from the potential of IT and contribute to the knowledge intensive products and services sector.
- v) It will involve educational and R&D organizations in every segment - Arts, Sciences, Engineering and Technology, Economics and Commerce, Health, Agriculture, industry, etc. - having the freedom to use its services over the broadband and satellite network.
- vi) It will help develop capabilities in the area of information systems and knowledge management for diverse domains like education, agriculture, health, R&D, e-governance, rural development, industry, etc.
- vii) As an advanced inter-institutional interdisciplinary postgraduate study and research centre, NCAI will groom the kind of professionals and researchers needed as information systems planners, builders, and managers in diverse fields of the future. Scholars and teachers from diverse institutions will use NCAI for their studies related to information systems and management in their respective disciplines. They will add to the thrust for taking India to the forefront of knowledge driven economy in the world.
- viii) It will assist institutions of higher education and research to serve their future role as knowledge resources and services centers in their respective domains.

It is now indispensable for organizations to build in such knowledge management practices in their own daily functions. They need to study their own behaviour constantly to assess themselves how they can function better, seize such opportunities in ways that will add value to themselves and the country at large. **Organizational learning is as indispensable as personal learning.** NOKG Mission with NCAI as the coordinating agency will practice the culture of learning organization and also assist in building the same in other organizations. In the process, the proposed institution will promote the appropriate and effective applications of IT facilitated services in every organization.

7.2. NCAI AND MODERNIZATION OF R&D ORGANIZATIONS

NCAI and NOKG fill a major void in the way higher education and research programs are supported. Today, almost no organizations outside a few sectors of industry and commerce

today really understand the need or have the capacity to manage the generation, maintenance and effective applications of large volumes of scientific and other data and utilize the same in ways that sustain knowledge enabled wealth creation. Growth of scientific research in India has been impeded to a great extent by the absence of a data management and open publications friendly culture in practically all our organizations. **Support for Knowledge Intensive Products and Services requires that every institution, program and services activity in the future needs to build a healthy culture in servicing web-accessed and regulated flow of generation, validation, presentation and applications of data and consequent decision support services.** This will require them to equip themselves and imbibe the tremendous capacity of emerging information systems with the tools and practices of knowledge management in their daily functions and processes. This capacity has become essential for the healthy survival of our institutions in a globally competitive networked world. NCAI will promote this development through the NOKG programs and make it available for the KVVU programs.

NCAI's mandate will be to foster networking of information, knowledge collaboration and KIPS across institutions and between institutions and society at large. In Mahatma Gandhi's words, "It is everyman's right to be independent, and equally it is everyman's duty to be interdependent". This is also true of institutions. SAI and VLC will formally nurture such interdependence of institutions that creates value from the synergy of their respective strengths. Such nurturing of interdependence provides rich frontier level research problems of the future, as it sustains the necessary fertile ground for identifying real-world issues, problems and ideas - areas where the scholars and experts hone and apply the theories, models, simulation and design they learn. With the above versatile structure and unique positioning, the new NCAI will emerge by itself as a frontier level R&D and advanced information services centre. It will also help other universities, institutions and organizations to raise their standards of education, research and services.

7.3. SUMMARY OF THE ROLES OF THE NATIONAL OPEN KNOWLEDGE GRID

The base concepts and systems underlying the NOKG are discussed in [1,5,6]. **A Knowledge Grid is much more than connectivity or content.** It serves as effective workspace for any virtual community that offers knowledge driven services. Examples of such knowledge communities include specific community of experts and academicians maintaining a portal for education and serving the community of learners in a particular subject. Another one may

be a community of experts editing and refereeing open access publications in a selected area. A third example may be a group of Agricultural experts support technology transfer under extension services.

Here we illustrate two abstract aspects of what a knowledge grid is supposed to provide to the users of the NOKG.

1. NOKG will support any number of Virtual Knowledge Communities with a disciplined and coherent information generation, information dissemination, collaboration, relevant knowledge base, learning and decision Support and for them to work.
2. NOKG is built as several layers. The lowest layer is the network, broadband, EDUSAT and such connectivity. These are becoming available through developments in Telecom, ERNET, State Wide Area Networks (SWAN) and such developments.
3. The second layer is the LAN access gateways and network services like email, college portals, systems, college automation and such others. The third layer consists of Digital Library, open access publishing, streaming servers, Learning Management Systems, computing facilities, discussion forums, college portals and such systems that make the students and teachers use the ICT systems effectively and as part of their daily work and studies.
4. The fourth layer of NOKG will establish subject area specific portals and grids and support the 'Virtual Learning Campus' as given in [3]. Such subject grids will support any number of virtual communities backed by relevant experts group.

NOKG will adopt an open development approach - suggesting ideas, eliciting responses from specific stakeholders inviting proposals from them and arriving at constructive proposals for each of the thematic services development and deployment in the different sectors. It will take a wholly enabling approach. It will also assist (if so desired) in other organizations coming up with similar initiative and deploying such services over the NOKG. It will serve as a watchdog to ensure interoperability, consistency and quality of services in the deployment of such services. In short, the three key NOKG areas are:

(a) Enabling Role: Ensure that systems, networks and services are deployed to build the grid and the associated services by diverse thematic communities.

(b) Educational Role: Help establish effective TELT practices backed by advanced and well

managed learning management and collaboration systems and subject-specific portals in ways that support quality education to all independent of geography.

(c) **Empowerment Role:** Establish and equip thematic communities over the NOKG with appropriate mix of experts from different organizations to provide demand driven services of value to farmers, citizens, patients, industries seeking consulting services, scholars, students, participants in continuing education, officials and anyone seeking such value added services.

This leads to the kind of programs management functions as indicated in Fig. 8. Here the different thematic groups with members from different organizations are facilitated through systems and grid facilitated processes supported by the NCAI under the NOKG programs. The different institutions themselves offer their independent programs over the technology enhancements provided by the NOKG. A different simplified view of the same is shown with the NOKG acting as the 'Knowledge Bus' in Fig. 9.

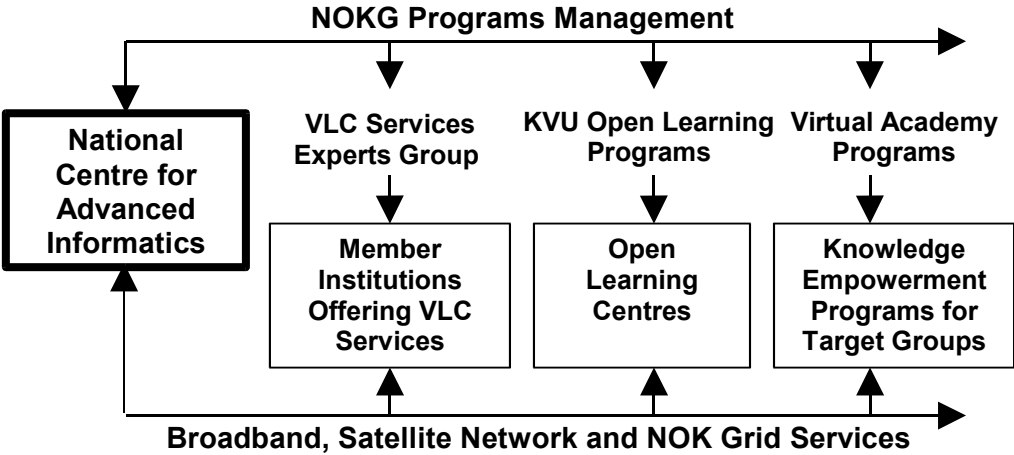


Fig. 8: NCAI and NOKG Programs Facilitation

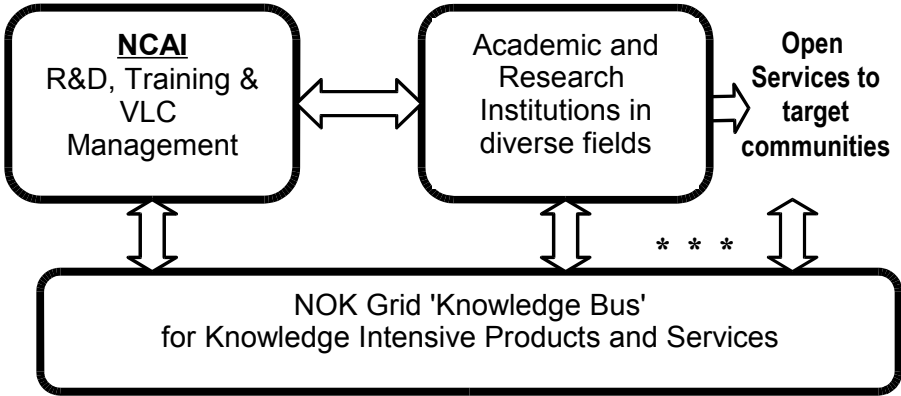


Fig. 9: NCAI and NOKG Knowledge Bus

8. ON NPTEL, EDUCATION GRID AND THE NOKG SUPPORT TO QUALITY EDUCATION

Under the MHRD's National Programme of Technology Enhanced Learning (NPTEL), the seven IITs and the IISc have developed authentic eCourse content in more than 240 subjects of relevance to the undergraduate engineering education. These are in the form of recorded video lectures of more than 5000 hours in about 115 courses and also as web-accessible content in about 120 courses. The intention of the NPTEL is to do something concrete to enhance the quality of education in the engineering colleges. These are being released shortly for use in the colleges. **The issue now is how to leverage upon this content, deploy them in the colleges across the country and support quality educational processes so that the quality of education offered is substantially enhanced and the large number of graduates coming out of the colleges are both employable and professionally competent to take up real-world challenges.**

Concurrent with the developments under the NPTEL, the Indian Institute of Information technology and Management - Kerala (IIITM-K) and the state's Department of Higher Education commenced the Kerala Education Grid. Under the Education Grid it established e-learning resource centers at IIITM-K, Cochin University of Science and Technology and National Institute of Technology - Calicut and College of Engineering Trivandrum. More importantly, **the Education Grid centre at IIITM-K has developed a whole gamut of systems and processes needed to support effective technology assisted instruction in the colleges.** The kind of systems needed and the parameters that constitute excellence in education are briefly outlined in [1]. Education Grid also developed models on quality of content using a Content Quality Metric [2]. Further, it developed some approaches on how we may deploy and use this content effectively in the colleges to enhance the quality of education very substantially. These are reiterated in Section 3 of this proposal. In the next section, we first review the systemic problems in our higher education, particularly with reference to the colleges and universities that have prevented them from offering quality education to our vast number of students. The proposed NCAI is largely the expression of the institutionalization of Education Grid services over the NOKG under different institutional programs.

Our country's economic growth and social equity is largely hampered due to the present mediocre education system. Here we recall [1,3] the Malcolm Baldrige parameters of educational excellence enunciated by the National Institute of Standards Technology (visit

http://www.quality.nist.gov/Education_Criteria.htm) that outlines the assessment areas to evaluate the quality of any institution. The details are available in reference [3].

8.1. A TECHNOLOGY ENHANCED APPROACH FOR QUALITY TECHNICAL EDUCATION

In Section 2 we already stated the several systemic problems in our Higher Education. Here we outline how we use the authentic content of video lectures and web-course material generated under the NPTEL to improve the quality of education. We assume that the colleges are connected over the VLC as given in Fig.5 and equipped with Learning Management Systems like the Moodle or Acado. They are to be serviced using specific NOKG programs and services. Here we show the stages of launching the collaborative support system for the engineering colleges using NPTEL content.

Step 1: First we set up basic streaming server over the LAN in the concerned colleges. The streaming servers are supplied with compressed streaming video lectures. Systems for this using FOSS are readily available in IIITM-K under its Education Grid services.

Step 2: For each subject, a Portal accessed Moodle LMS (or similar LMS) is installed. The discussion forums and other interactive services in the subject are backed by two or three experienced teachers and eminent academicians in the subject. These subject experts moderate the discussions and help edit supplementary content.

Step 3: Each subject NPTEL content is divided in to several learning modules. For each module the teacher is supplied a Learning Activities Template (LAT) that may follow a typical Gagne's 9 steps of instruction as given below. (Suitable pedagogic models may be chosen as suited to the subject).

1. **Gain Attention**
2. **Inform learner of objective**
3. **Stimulate Recall of Prior Knowledge**
4. **Present the Material**
5. **Provide Guidance for Learning**
6. **Elicit Performance**
7. **Provide Feedback**
8. **Conduct formal module test**
9. **Enhance Retention and Transfer**

Each of the above steps in a given module are mapped onto specific content, or, supple-

mentary content pointing to relevant learning activities. We follow the following Problem Based Learning (PBL) approach of developing content with good Content Quality Metric. For details the readers are referred to the papers [3,5]. The learning activities themselves are designed using the Tacit-Explicit interplay approach suggested in [5]. Thus a teacher follows the recommended instructional template in each module with the associated content and pointers to learning activities. Secondly, the LMS provides for rich interaction, self-test modules and students forums, subject specific wiki for new content aggregation and links to key journal papers and relevant references in the Digital Library, or links to important resources. Over time the subject content will grow with active contributions using open courseware and open forums like wikipedia.

The steps describing TELT processes are rather detailed and we leave them to the downloadable references. Here we briefly state the two significant components that will have to be added as supplementary content. The first is the five components of the content following the PBL (Motivation - Activation - Demonstration - Applications - Challenges, or MADAC) Model as given in the instructional cycle below.

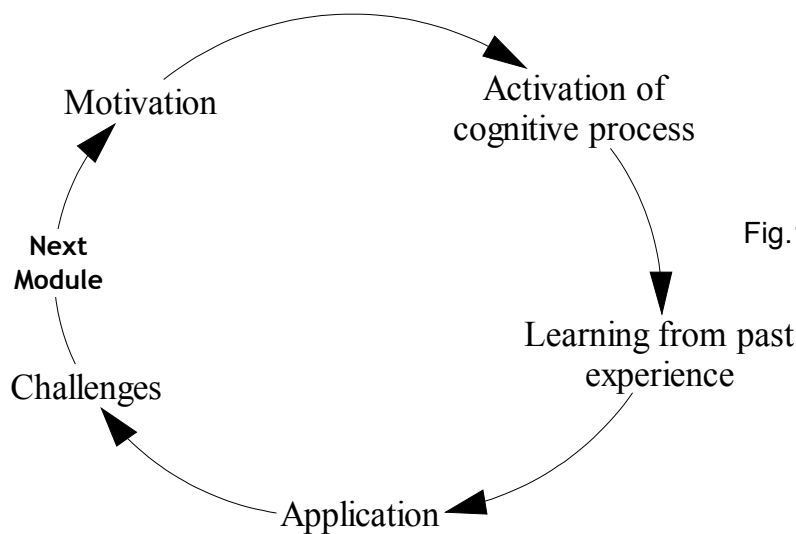


Fig.10. The Five components of instructional steps in Problem Based Learning.

The spirit of the learning activities designed for imparting effective instruction are categorised in the Tacit-Explicit mix. These are summarised here from [5].

- i) **Tacit to Tacit Communications:** This is best done by involving the students in learning situations through socializing amongst the learners and the teacher(s). Apprenticeship is one example of socializing. Group discussions and participation in course discussion boards are ready ways of socialize. Situations of team playing, or field work may be designed and

added in the course web area for teachers and the class to practice.

- ii) **Tacit to Explicit communications:** This is referred to as externalizing. Here we design and involve students in learning activities where by the students study a situation, review a paper and articulate the same as term paper, or design and deliver a presentation in the class. This provides for capacity building in articulation and communication skills in the context of the subject. Such learning situations in our teaching are almost not there in our classes - exams - marks type education. It is important to look beyond the syllabus into what its relevance is real-world context. Well designed and conducted externalizing activities will overcome this lacuna in our instructional process.
- iii) **Explicit to Tacit internalization:** This is what is attempted, though feebly in our text book - class notes study, homework and exams type learning. This too has large scope for improvement if we develop content as per the CQM model with rich anecdotes and presentations on the history of ideas in the topic through quality content. Every subject or abstraction gets its meaning through its association with other subject areas or real-life situations where they are applied. In the NPTEL context, several faculty have attempted to provide interesting episodes from real world that makes the subject interesting and motivating for the students. Over time, this part can be enhanced by supplementary lectures by eminent experts in the field and adaptation of new modules to keep pace with changes. This will build the much needed agility in our technical education.
- iv) **Explicit to explicit communications:** This deals with how ideas taught in the class appear in real world situations or in a different context or another subject. This is hard for any teacher without experience to build and address. These are best published in the course portal area as authentic and validated case studies and examples provided by a refereed process. NPTEL Phase-II with the Education Grid approach may start a 'Journal of Effective Learning' as an e-publication to invite such case studies for inclusion in different courses material.

There are a number of steps we have to take in the Higher Education system to free it from the systemic problems of the present narrow parsimonious and rigid educational framework. The root cause of the problem in today's education is that even good teachers do not have the freedom to innovate because they are made passive spectators of the syllabus-class-exams-pass percentage scenario. The freedom of a teacher to innovate is exists only when the situation is changed to the teacher himself/herself is allowed to examine (at least

partially to start with) his/her class. Any good education system must be centred around the facilitation of the teacher. In today's system, the teacher is almost bypassed. Very few Professors in universities write project proposals to build labs or educational resources. There is no ownership with associated pride in building something novel in education.

To overcome this systemic problem of self-perpetuating mediocrity, we have to adopt a series of steps to rejuvenate the education system. Here below we provide a suggestive roadmap assuming that the knowledge infrastructure of NOKG is available.

1. First introduce NPTEL content, an open wiki approach to build supplementary content along the lines of the PBL model. They are immediately useful as reference for the teachers. These will be done over subject specific portals whose services are available to all students and teachers studying the subject.
2. Next build the Learning Activities Template facilitated TELT facilitated instructional processes. Introducing such processes requires extensive teachers and management orientation programs that is best taken up by the NCAI.
3. Introduce in part the concept of teachers evaluating their own students. The exam papers and model solutions may be sent by the experts group associated with the course. Today's system of technical and affiliate universities does not bestow any trust on the teachers. This is just not tenable in any good education. Introduce relative grading rather than absolute marks. It allows for setting papers that can examine capacity of the student to think beyond the cookbooks. Many innovations are possible in the evaluation process. But this will not happen in the present over centralised examination system. Today most of the energies of teachers are taken up in exam papers correction, not in studies or interaction with students.
4. The Technical and Affiliate university bodies must give up control of examination in the large number of colleges in a phase manner, but have much better monitoring mechanisms in place.
5. Keep the government controls away from the Higher Education System as much as possible. Like the way our economy was liberated since the early 90s paved the way for our economic growth, decontrol and deregulate the higher education system and let colleges compete in open spirit.
6. Ensure more flexibility in the choice of courses and more dynamic career options. For

example strengthen B.Sc. Curricula and provide for professional careers in engineering and health education after the B.Sc. programs. In most countries medical education is after a basic degree. Our medical education, though provides good education in clinically practices is woefully short of people with research or management capabilities. Students who migrate from one discipline to another bring much innovation in their profession. Indian education is far too rigid branding some one as Electrical Engineer, another as Mechanical Engineer, a third one as a Physicist, etc. Over time and maturity there are many who will migrate towards their naturally strong areas.

Our universities and colleges will soon face globalization in ever increasing measure. Unless we do build something like NOKG and several support services for the higher education sector, our institutions will become slowly irrelevant. The author has been to numerous colleges, discussed with them and found them and the students very receptive to the kind of changes indicated in this proposal. Only the excessive control of the universities and the government is coming in the way of planned introduction of the changes.

9. A SUBMISSION

The biggest difficulty we as educationists face in this country is that the present regulatory system of education under different government bodies keeps out a vast number of competent professionals and good teachers from contributing to our educational system. No doubt there will be a cost, but it is insignificant compared to the gains we make. In technical education alone if we notionally charge a technology services fee of Rs. 200 per month, or, say Rs. 2000 per year and about a million students pay it we can cover recurring charges of Rs. 200 Crore per year. This is more than sufficient to establish the NOKG and provide web-accessible resources and instructional support processes over the NOKG. We may do similar exercises for other subjects as well.

It is about time the bodies like the UGC, AICTE, the Departments of Education and the Directorates of Education in the states see that a substantial constructive intervention with an enabling approach is announced and formulate along the lines given in this proposal. If the government opens up, the society and institutions are more than ready to go ahead. With the proposed introduction and absorption of TELT supported education methods backed by expert faculty of good institutions, we will not only address quality education, but create entirely new national discussions by thousands of teachers and students on what constitutes good education and learning practices.

We propose that India as a whole takes up the establishment of NOKG under a mission mode coordination executed through the NCAI. We may have a mission governance and management structure like that of the ADA/LCA. Typically it will be as follows.

1. Chairperson and the Governing Council

ISRO/DoS Chairperson (assuming DoS may be the hosting Department), or, one of Chairpersons of the IITs may be the Chairperson. Governing Council to have broad representations of one eminent person from each of the key stakeholders: IITs, UGC, AICTE, CSIR/DST, ICAR, IIMs, DIT, Industry-HR, CBSE, DRDO, etc. as deemed fit.

2. NOKG Mission executive head will be the Program Director. There will be specialist Project Directors for each of the major areas of NOKG like Technical Education, CSIR, Medical Education, Agricultural Education and Extension, Technology Development and Deployment, Training and Capacity Building, Visitors Programs, etc. as needed.

3. Under the Project Directors we shall have the teams of professionals to service the corresponding developments and portals management.

4. We shall also have visiting scientists, academicians, teachers and research scholars programs.

Further details may be worked out once the proposal is broadly accepted and launched at the national level.

The NOKG Mission may be largely self-financing if we are allowed to levy a technology services fee of Rs. 2000 per year per students in the professional courses and Rs. 1000 per year per student in the arts, sciences and commerce courses. We expect this levy will generate an annual revenue of Rs. 500 Crore. Initially we need a budget grant of Rs. 100 Crore. Of this about Rs. 50 Crore will go towards establishing the NCAI in a few acres campus (like the ADA) with 100,000 sq. ft. of high-tech built-up space, its own datacenter, with a total of 80 core staff consisting of a mix of eminent academicians, scientists and professionals to drive the NOKG program. The staff will be complemented by a large number of associate academicians, scientists and professionals. To keep the competency levels high, the NCAI will host a referral Advanced Informatics Laboratory, an EDUSAT classroom, and conduct postgraduate level programs in Informatics, Information Systems and Sciences, Computational Sciences, Applied Informatics in different major domains, Humanities and Management.

We suggest that the National Knowledge Commission sets up a small and functional working group to come up with the detailed structure and programs of the NOKG Mission. IIITM-K is the best suited institute to take up the work.

A sum of Rs. 50 Lakh may be released (under NPTEL) may be released as seed fund to IIITM-K to set up broad consultations across the many institutions, host consultative workshops across the country and finalize the NOKG Mission Mode program details. Until NCAI is formed, the Education Grid of IIITM-K will act as the meeting ground and servicing institution for the whole effort. The final Mission Launch document will be submitted within six months of the release of the seed funding. The present Programme Implementation Committee of the NPTEL may also be concurrently made the Technical Education Modernization programme as the first one fitting within the broad mandate of the NOKG.

We may note that much of the concepts that goes into the NOKG have been deployed in small ways at IIITM-K and commissioned into pilot services. This 'sounding out' proposal is hereby submitted initially to the following organizations/persons.

- i) National Knowledge Commission
- ii) Member Science and Technology, Planning Commission
- iii) Executive Director, ERNET, Department of Information Technology
- iv) Chairperson, NPTEL (Director, IIT Madras)
- v) Chairperson ISRO
- vi) Chairperson IIITM-K
- vii) Chairperson, IIT Kanpur

The document will also be made available under the title "Proposal for a National Open Knowledge Grid in the publications page of the Education Grid portal www.edugrid.in. IIITM-K is ready to host a national workshop on this concept at earliest.

10. ACKNOWLEDGMENTS

Over the last 8 years the author has been working with different teams starting from IIT Kanpur, with DIT, subsequently since 2001 from IIITM-K on the diverse systems and processes related to the components through projects and commissioning some of them to services. In this he has been ably assisted by a large number of persons - too numerous to acknowledge

here. He conveys his sincere gratitude to each and every one of them. However special thanks go to the Government of Kerala and the Board of IIITM-K for giving him the freedom to explore and establish (at time) bold new concepts and systems in education and institution building, and works that naturally lead to this proposal.

11. REFERENCES

All the references cited below are available for download from the Education Grid Portal's Publications page.

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4. K.R. Srivathsan, "Five Laws of Information Science as Basis for Architecting Knowledge Infrastructure for Education and Development", A paper in honor of Prof. A Neelamegham appearing in the Festschrift for his 80th Birthday.
5. K.R. Srivathsan, " Management of Refereed Content Generation and Utilization in Formal Education".
6. K.R. Srivathsan, "Concurrent Instructional Services over NPTEL Content for Quality Enhancement of Education." Invited paper of the CSI Annual Convention, Hyderabad 2005.
7. Also visit www.okiproject.org

Apologies!

There are several major Grid related projects in the world particularly in North America and Europe that may be worth citing as references. But in the Indian context they are more relevant from technology perspective and not so much from our national perspective. They will be duly reviewed in the final proposal.

Submitted by

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