

# ITRA Progress Report

2010-15

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## Executive Summary

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Information Technology Research Academy (ITRA) is a National Programme aimed at building a national resource for advancing the quality and quantity of R&D in Information and Communications Technologies and Electronics (IT) and its applications at a steadily growing number of academic and research institutions, while strengthening academic culture of IT based problem solving and societal development. ITRA is currently operating as a Division of Media Lab Asia, a Section-25 not-for-profit organization of Department of Electronics and Information Technology, Govt. of India.

Focus Areas with societal relevance are chosen for conducting research and development. To begin the pursuit of a selected focus area, a Strategy Formulation Meeting (SFM) is held to identify and discuss different aspects of the area and evolve a roadmap. Well known researchers and other relevant experts in the focus area, from India and abroad, are invited to the meeting. Subsequently, multi-institution teams are identified to conduct collaborative projects, each implementing a part of the SFM roadmap in the focus area.

ITRA uses a pyramid model to interlink the institutions in the team (called ITRA Institutions, or IIs), wherein each II acts as a Lead Institution (LIN) for a set of Partner Institutions (PINs) in the next lower layer in the pyramid. Each PIN learns from its LIN immediately above, while it simultaneously helps improve the quality of its own PINs at the level immediately below. The pyramid grows after every growth cycle (of a predetermined period of, e.g., 2 years), via each PIN in the lowest layer acquiring a set of new IIs as PINs and serving as a LIN for them.

A team consists of (i) researchers from academic and research institutions, any additional disciplines needed to pursue the team's objectives. The node IIs closely collaborate with the translators to add or extend the team capabilities in translating their R&D into societal impact, e.g., through technology transfer to industry, startups, etc. (iii) Each team must also include Mentors who have agreed to be involved in the project. Mentors are renowned scientists, technologists, industrialists, etc., and an integral part of the team. They will mentor the rest of the team from the proposal stage through the actual activities, including planning, publications, these supervision, and general professional guidance.

To maximize the likelihood of a match with ITRA expectations, a two-stage process will be used for teams to efficiently develop proposals. In the first stage, a brief Expression of Interest (EOI) statement will be submitted by the lead institution of a team. This will help ITRA arrive at a preliminary assessment of the proposed effort and provide any feedback that may help improve the chances of eventual acceptability of any full proposal that follows. Those teams with acceptable EOIs will be invited to submit a full proposal. ITRA may provide inputs about the thrust of team's proposal, potentially useful groupings among selected teams, etc. The second stage will be submission of a full proposal. The information required in the EOI is a small part of the full proposal.

After the teams have been selected, ITRA proactively and continuously work with the teams to identify the needs and opportunities to maximize performance. ITRA will arrange for the necessary resources and mechanisms and pyramid-wide access to them. Achievements by teams will be recognized through a variety of awards given for quality of their proposals to begin with, to quality of work done by individuals, institutions and teams, at different stages of the work, with respect to all four ITRA quality metrics mentioned earlier.

ITRA began with two focus areas, viz., "Mobile Computing, Networking and Applications (*ITRA-Mobile*)", and "IT based Innovations in Water Resources Sustainability (*ITRA-Water*)". In *ITRA-Mobile*, 9 teams, consisting of 34 groups, and in *ITRA-Water*, 5 teams, consisting of 20 groups, have been selected and are currently engaged in research and development projects identified in their roadmaps. The anticipated number of PhD students targeted to be involved in these two focus areas during the current 3-year project period is around 200. Two more focus areas, "IT Transformations in Indian Agriculture and Food (*ITRA-Ag&Food*)" and "Human Simulator for Amyloids Related Diseases (*ITRA-HuSim*)" has also been initiated, and the selection process is currently ongoing.

## Objectives

The main objective of ITRA is to achieve competitive advantage in IT and increasing the national R&D capacity, both quantitatively and qualitatively. This will be accomplished by:

- Building R&D Groups in IT
- Networking the Groups and connecting them to Industry and Society
- Producing high quality PhDs for Industry, R&D labs and Academic Institutions
- Enabling innovation in IT
- Enhancing societal problem solving skills

ITRA is designed to produce a large numbers of IT researchers who are well equipped with the latest IT knowledge, educated in relating classroom knowledge to developing solutions, trained to spot problems amenable to IT solutions, motivated to identify societal problems in IT and other domains, and exposed to mechanisms for converting lab solutions to working prototypes. ITRA activities are aimed at a major increase in the national capacity of producing PhDs who could become faculty in academic institutions and address the needs of the industry and society at large.

## Mission Statement

To build a national resource for enhancing the quality and quantity of in Information and Communications Technologies and Electronics (ICTE, or IT for short) and its applications, in IT and related institutions across India.

## Mechanisms and Keys to Success

ITRA uses a pyramid model of increasing the number of partner institutions. Each institution learns from its mentor institution located at the next higher level, while it simultaneously helps improve the quality of its own mentee institutions at the level immediately below. Thus, coexisting mentor-mentee interactions simultaneously raise quality across the pyramid with time, while fresh, lowest tier institutions are steadily added at the bottom. This leads to an exponential growth in the number of ITRA partner institutions. The R&D enhancement activities include:

- i. **Multi-disciplinary Team Formation:**
  - a. Teams are formed consisting of academic institutions or R&D labs of different quality and disciplines, with varied geographical spread;
  - b. If needed, non-academic partners are included as collaborators, e.g., Govt. organizations, R&D labs, industry and NGOs focused on:
    - A basic IT research problem, or
    - Applying IT to an important application domain
- ii. **Focus Area Identification, Project Review and Initiation:**
  - a. Focus areas are identified based on national priorities, need assessment and opportunities.
  - b. For each focus area, specific projects are defined through Strategy Formulation Meetings of national and international experts and stakeholders.
  - c. Projects are initiated for implementation.
- iii. **Enhancement of Quality of R&D at ITRA Institutions:**
  - a. Eminent experts are invited to nurture R&D teams in emerging areas and collaborate with ITRA Institutions/Faculty
  - b. Fellowships, awards, professorships, etc., are given to recognize performance
  - c. Researchers are exposed to state of the art facilities, best practices and mentorship
  - d. Programs are formulated to promote creativity and innovation through nurturing societal sensitivity

- e. Mechanisms are defined to transfer deserving technologies developed by the teams to companies, etc.

ITRA engages world renowned researchers as Mentors and Adjunct Faculty to help the partner institutions by motivating research groups, conducting research, guiding students, teaching new classes, evaluating status and discussing/implementing changes, if needed. Pooling experts from across the world offers the partner institutions an opportunity for incorporating the best institutional practices followed across the world.

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## About ITRA

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ITRA was initiated by Department of Electronics and Information Technology (DeitY), Ministry of Communications and Information Technology (MCIT), Government of India, as National Programme to help build a national resource for advancing the quality and quantity of R&D in Information and Communications Technologies and Electronics (ICTE, or IT for short) and its applications, in IT and related institutions across India. The core areas of IT lie in various engineering disciplines, notably computer science and engineering, and electrical engineering, although applications may come from almost any discipline. ITRA focuses on strengthening the nation's competitiveness by expanding the R&D base in IT, especially by leveraging the large IT education sector and IT users such as government, industry and other organizations. The enhanced IT R&D capacity created through ITRA will impact the overall ecosystem of Information Technology, to be reflected in the numbers of research groups and labs created, new research areas initiated, scale of PhD graduations, new curricula, innovative solutions to industrial and societal problems, strong linkages with R&D groups, etc.

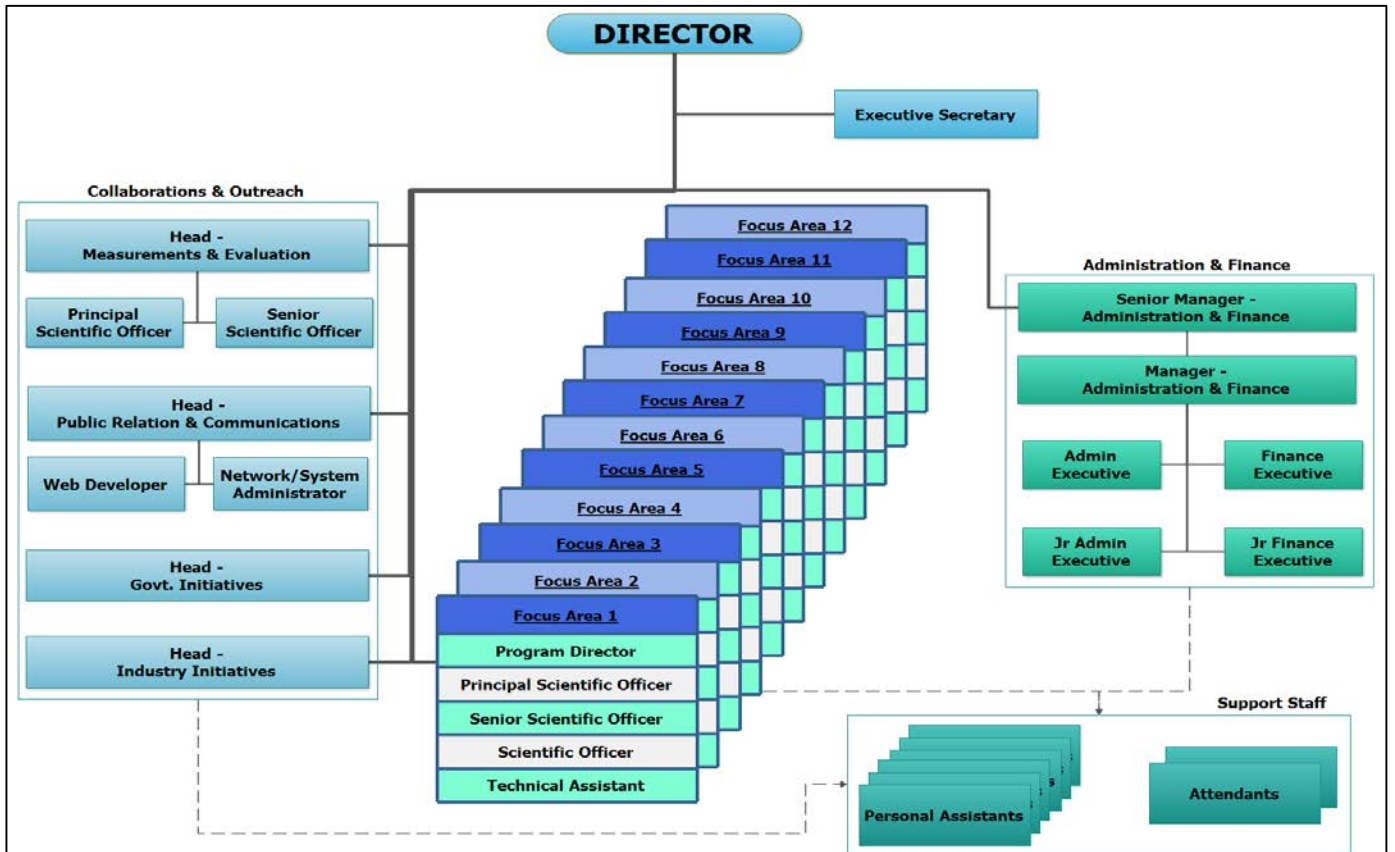
Implementation of the five year 'ITRA project' with a total outlay of Rs. 148.83 Cr was entrusted to Media Lab Asia (MLAsia) a Section-25 not-for-profit organization of DeitY, by DeitY in November 2010. The project commenced with the release of first installment of the grants on Dec 2010. ITRA is currently operating as a Division of MLAsia.

### Governing Structures

- a. **Governing Council (GC):** ITRA GC was setup with the approval of Hon'ble MCIT and is chaired by the Secretary, DeitY. The GC has representatives from MHRD, Academia, and Industry. ITRA GC provides general guidance and supervision. It has full powers to decide and approve various policy matters of the ITRA.
- b. **Advisory Council (AC):** ITRA AC was setup with the approval of Hon'ble MCIT and is chaired by Prof. S. V. Raghavan, Scientific Secretary, Office of the Principal Scientific Advisor to the Government of India. The AC consist of eminent persons and visionaries from IT, IT-in-X and related policy-making areas and from other disciplines of relevance. ITRA AC recommends the high level priorities and agenda for IT research. Any ideas about new focus areas need to be first presented to and recommended by AC.
- c. **Executive Committee (EC):** ITRA EC was setup with approval of ITRA GC and is chaired by Director-ITRA. This committee takes all decisions needed to implement the approved policies. Overall, EC will provide guidance to ITRA for effective execution of the programme.
- d. **Program Review and Steering Group (PRSG):** A new committee added by DeitY in Oct 2014 to oversee ITRA, viewed as a DeitY project. PRSG approves all decisions that have to do with the government functioning and regulations, including those made as per policies recommended by AC and approved by GC and MD. It is overseen by the DeitY Group Coordinator for IT.

The composition and Terms of Reference (TOR) of all committees is placed at ANNEXURE 1

## Organization Structure



List of ITRA personnel is placed at ANNEXURE 2.

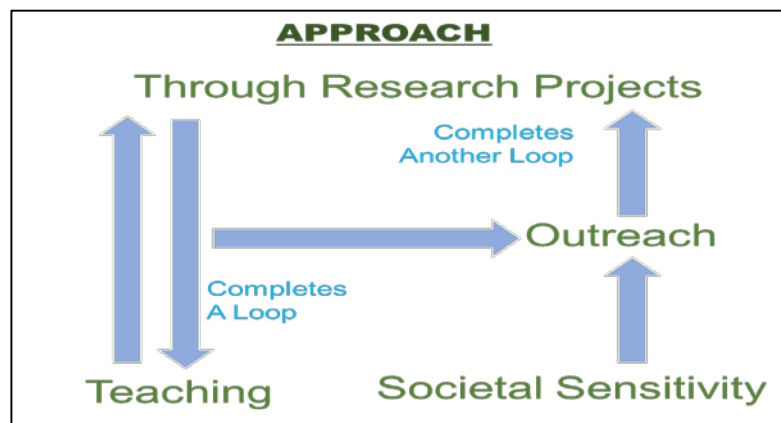
## Location

ITRA is currently operating from 2<sup>nd</sup> Floor, CDOT Campus, Mehraulli, New Delhi. Earlier, i.e. till Dec 2014, ITRA was operating Electronics Nitekan, CGO Complex, New Delhi.

## ITRA Model

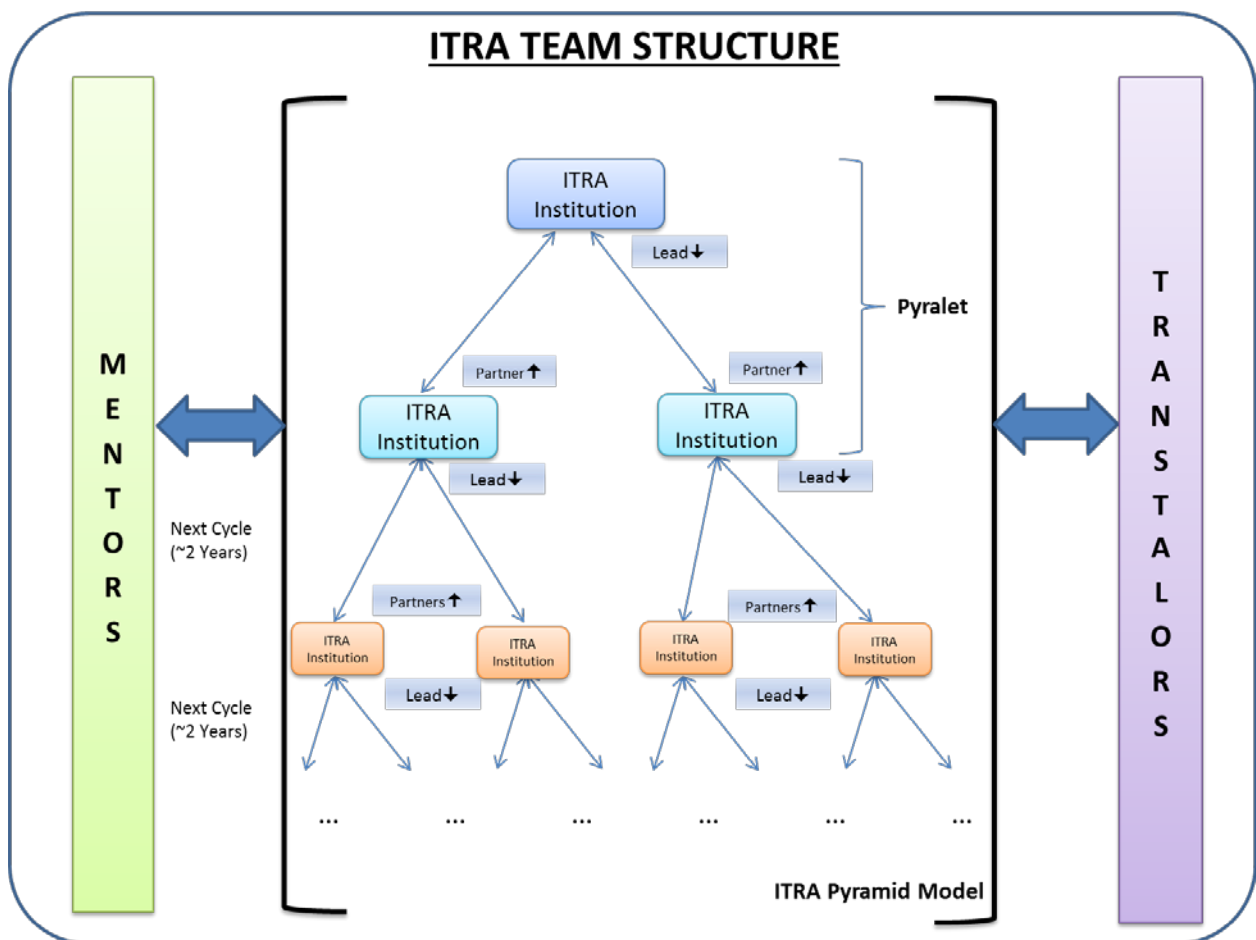
ITRA is aimed at building a national resource for advancing the quality and quantity of R&D in Information and Communications Technologies and Electronics (IT) and its applications at a steadily growing number of academic and research institutions, while strengthening academic culture of IT based problem solving and societal development. The core areas of IT lie in the various engineering disciplines that involve handling of information, notably computer science and engineering, and electrical engineering, although applications may come from almost any discipline in, and importantly, beyond engineering.

Quality is measured in terms of the following four parts: the R&D work itself, aimed at developing skills of problem formulation and solving, as reflected in commonly used metrics (publications, etc.); impact of the R&D on enhancing curriculum and instruction; programs for developing sensitivity to society, so the researchers tend towards routinely spotting societal problems and developing an urge for solving them as targets of their R&D work; and making an impact on society at large through entrepreneurial activity or other ways of transferring technologies and knowledge developed in the R&D work.



ITRA plans to enhance the quality of the ITRA institutions (to be referred to as IIs in the sequel) through R&D, by closely interacting teams of researchers and institutions that have expertise in specific IT research areas, or in the use of IT in other engineering and non-engineering domains. To realize effective interaction among increasing number of institutions, ITRA plans to network these existing institutions as a pyramid. All IIs will be academic institutions or Government Supported Research Laboratories. They will form the nodes of a pyramid. These IIs will closely collaborate with non-academic institutions, such as research labs, industry, Government organizations and NGOs, the latter typically adding or extending the capabilities of the IIs in translating their R&D into societal impact, e.g., through technology transfer to industry, startups, etc. As is well recognized, such translation of technical innovation into societal impact requires much more than the innovation itself. Thus, the participation of non-academic institutions is central to achieving the objectives of ITRA. However, this role will be played by them through collaboration with the IIs in the pyramid as the primary target of ITRA is enhancement of the quality of academic/research institutions. A critical other component of the ITRA teams will be the presence of world class scientists, technologists, industrialists, etc., as central players and an integral part of the team, who will mentor the rest of the team from the proposal stage through the actual activities, including planning, publications, these supervision, and general professional guidance.





Each problem P in the focus area identified as important will be addressed by a set of pyramids. The problems will be divided into sub problems, and work on each sub problem S will be undertaken by N (N being one or more) interacting pyramids IP(s). The value of N will depend on the size/requirements of S. A more ambitious S may call for a larger number of IPs. Each IP will begin with an initial set of research groups, led by a Lead Institution (LIN) at the root level, with the next level formed by Partner Institutions (PINs), forming a two-level pyramid, called a pyralet. A LIN will distribute and carry out the project work jointly with its PINs, in the process bringing up the quality of the PINs. At the end of a cycle of 1.5-2 years after becoming an II, each PIN will be required to add a layer of 2-3 new PINs of its own for whom it will act as LIN.

The pyramid will thus grow in chunks, each chunk being the new layer of PINs added at the bottom, thus expanding the pyramid. The expansion will be done as soon as a PIN is ready, typically every 1.5-2 year cycle. An II may appear in multiple pyramids, associated with different focus areas, represented by II's different research groups. Those IIs with a broader research program will indeed tend to appear in the ITRA pyramids more frequently.

An II will typically improve its quality in a focus area with help from its LIN, its parent node in the pyramid, while helping raise the quality of its own PINs, its children nodes in the layer below. It is therefore envisioned that the entire pyramid will rise in quality with time, while layers of new PINs are added at the bottom. The rate at which the PINs are added to the pyramid will itself grow directly with the number of institutions in the pyramid, i.e., the pyramid size will grow exponentially.

The focus areas will either be disciplines within IT itself, or aimed at applying IT to an important problem domain X, referred to as IT-in-X. ITRA will help initiate IPs for each S, by selecting a set of seed pyralets for each S, based on a single proposal jointly submitted by the team. The primary

responsibility, accountability and rewards for the improvement in the quality of PINs in a pyralet will primarily flow through the PIN itself, its LIN and the mentors. However, collaboration within a team is preferred to be broader, to take advantage of the complementarities in the strengths of all IIs in the team. The teams will be established through initial grants. Future layers will be added during the same grant, through renewals of these grants or new grants.

ITRA will proactively and continuously work with the IIs to identify the needs and opportunities for achieving greater efficiency. ITRA will arrange for the necessary resources and mechanisms and pyramid-wide access to them.

Achievements by teams will be recognized through a variety of awards: starting from the quality of their proposals; to quality work done at the level of individuals, institutions and teams; at different stages during the work; with respect to all four ITRA quality metrics mentioned earlier.

The central roles of mentors may be complemented by involving other accomplished researchers and pertinent others as Adjunct Faculty as and when needs or opportunities arise.

ITRA will itself act as a central repository of the major advances (results, solutions, technologies, etc.) made by ITRA teams over time. As ITRA covers more and more focus areas, it should be in a position to serve as a knowledge source and a think tank for IT, and IT-enabled problem solving in an increasing number of domains.

### **Mechanisms to Select and Initiate Project Activities in a Focus Area**

Focus Areas with societal relevance are chosen for nurturing research with advice from Advisory Committee (AC) of ITRA. To begin the pursuit of a selected focus area, a Strategy Formulation Meeting (SFM) is held to identify and discuss different aspects of the area. Well known researchers and applications experts in the focus area, from India and abroad, are invited to the meeting. They are selected from the relevant government and nongovernment organizations, industry, etc., so as to represent the viewpoints of all stakeholder communities, including researchers, mentors, sponsors, developers, outreach groups, users, domain knowledge providers, etc. The SFM participants help formulate a comprehensive national research initiative in the area.

The SFM outcomes are used to prepare a Request for Proposals (RFP) to form ITRA teams working on the identified short-term, medium-term and long-term objectives. The RFP embodies ITRA's emphasis on team based work. All proposals are required to be submitted by teams. The team consists of academic institutions or government research labs (together referred to as ITRA institutions, or IIs) and other, collaborating organizations. Each team consists of:

- (a) One or more pyralets (defined as: one lead II and, typically, two partner IIs), and
- (b) Other collaborating organizations, if any, including research labs, industry, government organizations, NGOs, international organizations, etc., to complement the expertise of the IIs to form a well-rounded team that can help improve as many parts of the ITRA quality measure and to as large an extent as possible. These organizations act as translators of the pyralets.

To maximize the likelihood of a match with ITRA expectations, a two-stage process is used for teams to efficiently develop proposals. In the first stage, a brief Expression of Interest (EOI) statement is submitted by the lead institution of a team. This helps ITRA to arrive at a preliminary assessment of the proposed effort and provide any feedback that may help improve the chances of eventual acceptability of any full proposal that follows. Those teams with acceptable EOIs are invited to submit a full proposal. ITRA may provide inputs about potentially useful groupings among the selected teams.

The second stage is submission of a full proposal. Submitted full proposals are reviewed and shortlisted by a diverse panel of eminent experts from academia, industry, research laboratories, Government and other organizations as needed. Subsequently, the shortlisted collaborative projects are taken up in the selected focus areas.



## Post Project Award Engagements with the teams

ITRA and all teams will engage in the following periodic exercises to ensure healthy progress.

1. **Quarterly Team Meet for Inter Team Interactions:** PIs and Co-PIs of each team will meet every three months, to take stock of the progress and discuss the work that is to follow. After each of these meets, they will prepare a quarterly report, to be submitted by the PI to ITRA. The contents of the reports will be specified in a report template to be provided to the teams by ITRA.
2. **Semi-Annual Focus Area Meet for ITRA Feedback:** Along with the usual 2nd quarterly meet of the PIs and Co-PIs, there will also be a focus area meet aimed at providing feedback to the team. Each team, including PI, Co-PIs, PhD students and other researchers, will participate in this meet. A subset of the mentors along with other experts will provide their comments on the progress made and any suggestions to help enhance the quality of the planned subsequent work.
3. **Annual ITRA Meet for Performance Evaluation, Recognition and Planning:** This meet, coinciding with 4th quarter inter-team meets, will again be attended by the entire teams, including PI, Co-PIs, PhD students and other researchers, from all focus areas. One objective will be to evaluate each team's performance over the preceding year. Based on performance, a panel of mentors and experts will make decisions about whether in the following year the work plan of the team, participation of an II, the details of an activity, etc., should continue or if changes are needed, e.g., in the budgets, proposed work, etc. As another major objective, the panel would recognize students, IIs, entire teams, etc., for noteworthy performance with respect to the ITRA quality metrics and towards meeting various other ITRA objectives, by presenting various ITRA awards.

## ITRA Awards:

ITRA projects are fundamentally team oriented. Teamwork is necessary for many large undertakings in general, and it needs particularly strong attention in the Indian academia and research institutions. Towards this end, there is a need to have a performance linked incentive scheme (awards) for the ITRA teams. ITRA Awards are linked to the performance of the ITRA teams with respect to the fundamental objectives of ITRA. The policy for awards was approved in the ITRA Governing Council Meeting held on Oct 15, 2014. The summary of the awards is as follows:

Awards Category	Details
<b>PhD Research Award</b>	a) The award will have 2 levels – <b>Exemplary</b> and <b>Outstanding</b> , and will be given annually. b) The number of awards will be up to <b>5</b> at <b>Exemplary level</b> and <b>25</b> at <b>Outstanding level</b> .

	<p>c) Award amounts will be <b>2 Lakhs at Exemplary level</b> and <b>1 Lakh at Outstanding level</b>.</p> <p>d) These awards will be given twice i.e. at end of year 1 and year 2 of the project.</p>
<b>PhD Dissertation Award</b>	<p>a) ITRA plans to give <b>PhD Dissertation Awards</b>, in the form of a <b>citation only, without any monetary compensation</b>.</p> <p>b) PhD theses of the ITRA students will be evaluated for quality and impact and those theses meeting a quality threshold will be given the award.</p> <p>c) A <b>citation</b> along with a <b>gold plated medal</b> will be given to each awardee.</p> <p>d) These awards will be given twice i.e. at end of year 1 and year 2 of the project.</p>
<b>Team Achievement Award Grant</b>	<p>a) The award to the teams will be given in <b>3 categories</b>, corresponding to the following groupings of the ITRA performance metrics: <b>(i) Research, (ii) Curricular Impact, and (iii) Combined Societal Sensitivity and Outreach</b>.</p> <p>b) Up to <b>1 team per category per focus area</b> may be selected for the award per year.</p> <p>c) The award will have <b>2 levels – Exemplary and Outstanding</b>.</p> <p>d) The award grant amount will be either <b>Rs. 10 Lakhs (for Outstanding level)</b> or <b>Rs. 20 Lakhs (for Exemplary level)</b>.</p> <p>e) These awards will be given twice i.e. at end of year 1 and year 2 of the project.</p>
<b>Foresight Award Grant</b>	<p>a) Up to <b>1 team per focus area</b> may be selected for the award.</p> <p>b) The award grant amount will be <b>Rs. 10 Lakhs</b>.</p> <p>c) This award will be given once at the time of approval of projects, i.e. in year 1.</p>
<b>Partnership Achievement Grant</b>	<p>a) The award will have <b>2 levels – Exemplary and Outstanding</b>.</p> <p>b) The number of LIN-PIN pairs to be selected will be up to <b>1 at Exemplary level</b>, and up to <b>4 at Outstanding level</b>.</p> <p>c) Award amounts will be: <b>Rs. 6 Lakhs at Exemplary level</b> and <b>Rs. 3 Lakhs at Outstanding level</b>.</p> <p>d) These awards will be given twice i.e. at end of year 1 and year 2 of the project.</p>
<b>Interdisciplinary Collaboration Award Grant</b>	<p>a) The award will have <b>2 levels – Exemplary and Outstanding</b>.</p> <p>b) The number of awardee pairs to be selected will be up to <b>1 at Exemplary level</b>, and up to <b>4 at Outstanding level</b>.</p> <p>c) Award amounts will be: <b>Rs. 6 Lakhs at Exemplary level</b> and <b>Rs. 3 Lakhs at Outstanding level</b>.</p> <p>d) These awards will be given twice i.e. at end of year 1 and year 2 of the project.</p>

Details of ITRA Awards can be seen at ANNEXURE 3.

## Mentors

Mentors are renowned researchers in an area relevant to the team. They are an integral part of a team proposal and are thus involved from the time of the inception of the team. They are entrusted with and duly credited and rewarded for enhancing the team's performance. Types of Interactions between a Mentor and ITRA Teams are as follows:

1. Co-supervision of PhD/Master's student theses
2. Co-authorship of papers
3. Co-teaching of courses

4. Co-development and conduct of labs
5. Co-planning and steering of research agenda and formulating proposals
6. Giving seminars and short courses
7. Working with team collaborators and other stake holders
8. Hosting ITRA faculty and students at mentor's institution for short (~a few weeks) or long periods (~a semester)
9. Help with outreach efforts
10. Guide teams to contribute to national and international professional organizations and activities involving conferences, journals, contests, standards, multinational initiatives, professional societies, etc.
11. Be a member of team feedback panels
12. Be a member of team evaluation panels.

Details of Interactions of Teams with Mentors are available at ANNEXURE 4.

### **Adjunct Faculty:**

Adjunct Faculty (AF) are renowned researchers in an area relevant to the team. They may perform most of the functions normally performed by a mentor, but the mentors are an integral part of a team proposal, usually involved from the time of the inception of the team. AF are entrusted with and duly credited and rewarded for enhancing the team's performance. AF may also be invited to complement the mentors from time to time. AF may choose to become mentors if need arises as they work with the teams. Types of Interactions between ITRA Teams and Adjunct Faculty

1. Co-supervision of PhD/Master's student theses
2. Co-authorship of papers
3. Co-teaching of courses
4. Co-development and conduct of labs
5. Co-planning and steering of research agenda and formulating proposals
6. Giving seminars and short courses
7. Working with team collaborators and other stake holders
8. Help with outreach efforts
9. Be an invited member of team feedback panels if needed
10. Be an invited member of team evaluation panels if needed
11. Guide teams to contribute to national and international professional organizations and activities involving conferences, journals, contests, standards, multinational initiatives, professional societies, etc.

Details of Interactions of Teams with Adjunct Faculty are available at ANNEXURE 5.

## International Travel of Researchers

The principal objective of ITRA is to catapult the quality and quantity of advanced IT Research in India. Integral to this objective is further strengthening the sense of research quality and understanding of research methodology in the ITRA faculty, students and other team members, and building local and global collaborative relationships, including through interactions with mentors and other renowned experts in their domains.

One important way in which this can be realized is by helping Indian researchers present their work at international fora. In addition to the fact that most conferences accept papers under the condition that the each paper is actually presented by an author at the conference site, being at such conferences provides a valuable opportunity for face to face interactions and building relationships with professional colleagues. It is a standard method for the new researchers to connect and succeed. It may lead to closer collaborations and fruitful new research partnerships.

Since many of the major conferences are often held outside India, there is a need for supporting international travel by researchers. ITRA considers attending at least 2 good quality conferences annually to be essential for any research group to enhance the quality metrics by which their performance is to be evaluated. ITRA team members shall therefore be supported to present research papers at international conferences or workshops; etc. that have already been identified or accepted by ITRA as quality venues.

Details of International Travel of Researcher are available at ANNEXURE 6.

## Attracting UG and PG students early on to pursue PhD

To enlarge the R&D base, ITRA plans to attract deserving undergraduate/master's students early on, i.e. while they are in the midst of their study programs (2nd year onwards for UGs and 1st year onwards for MS). They will be given an opportunity to be involved in ITRA projects, and thus be exposed to the project's nationwide, growing and dynamic environment, and to world class research practices, fora and researchers. This should lead to a positive change in student's perception of pursuing PhD in Indian institutions.

Student interns on the project will be compensated at the rates used by IITs. The following rates, being used currently at IIT Kanpur shall be adopted:

- i. Interns working full time (during summers):
  1. UGs: Rs. 8k-16k/month for up to 40 hrs/week
  2. PGs: Rs. 12k-24k/month for up to 40 hrs/week
- ii. Interns working part time (during the academic term):
  1. UGs: Rs. 60-100/hr for up to 10hrs/week
  2. PGs: Rs. 100-200/hr for up to 15hrs/week

Students working on part time basis will be given an amount on pro rata basis. The internship awards are planned to be at 3 different levels.

**Selection:** Identification of student interns will be done via a rigorous evaluation of their achievements as well as research disposition. A committee of faculty from the institutions in the team considering offering internship to a student, chaired by the Lead PI of the team, will assign a grade to the student. The grade will determine if the student is an acceptable match to the project and a good PhD prospect, and if so, where on the capability scale s/he is placed, and therefore, what the internship award level within the specified range should be.

## ITRA Focus Areas

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Focus Areas with societal relevance and national priority are chosen by ITRA Advisory Council for conducting research and development. To begin the pursuit of a selected focus area, a Strategy Formulation Meeting (SFM) is held to identify and discuss different aspects of the area and evolve a roadmap. Well known researchers and other relevant experts in the focus area, from India and abroad, are invited to the meeting. Subsequently, multi-institution teams are identified to conduct collaborative projects, each implementing a part of the SFM roadmap in the focus area.

Initially to identify the relevant IT activities, ITRA held discussion with the related DeitY groups and their ongoing and planned or desired activities. Correspondingly several focus areas were identified as possible IT and IT-in-X areas for ITRA to pursue, to begin its activities. ITRA began with two focus areas, viz., “Mobile Computing, Networking and Applications (*ITRA-Mobile*)”, and “IT based Innovations in Water Resources Sustainability (*ITRA-Water*)”. In *ITRA-Mobile*, 9 teams, consisting of 34 groups, and in *ITRA-Water*, 5 teams, consisting of 20 groups, have been selected and are currently engaged in research and development projects identified in their roadmaps. Two more focus areas, “IT Transformations in Indian Agriculture and Food (*ITRA-Ag&Food*)” and “Human Simulator for Amyloids Related Diseases (*ITRA-HuSim*)” has also been initiated, and the selection process is currently ongoing.

### **ITRA-Mobile**

The Strategy Formulation Meeting (SFM) for the area *Mobile Computing, Networking and Applications* held during October 10-12, 2011. The meeting was organized to identify, discuss and develop a research and development agenda focusing on this area. The meeting was attended by participants from academia, government, industry and NGOs, from India as well as abroad. Based on this meeting a Request for Proposal document was created.

This focus area is primarily aimed at work in IT itself, instead of IT-in-X that targets applications of IT to important problems, per our general approach to selecting focus areas described in the plan document. Within IT, it is motivated by simultaneously realizing two desirable properties. First, it involves multiple IT disciplines. This is the result of the fact that the mobility, networking and applications aspects each impose different constraints on the basic formulation of the problems to be solved. Combining these with the characteristics of test-bed scenarios relevant to India brings in additional constraints. The result is the need for an integrated study of the following disciplines, each traditionally studied in the indicated familiar departments

- Communication Theory – Electrical Engineering
- Network Theory – Electrical Engineering, and Computer Science
- Graph Theory – Electrical Engineering, Computer Science, and Mathematics
- Dependable Systems – Electrical Engineering, Computer Science, Computer Engineering
- Communication Protocols – Computer Science and Computer Engineering
- Operating Systems – Computer Science

The traditional separation of these disciplines is the somewhat natural consequence of how they got introduced and evolved as subjects of study. The proposed ITRA structuring of the focus areas has the advantage of creating the desired but otherwise uncommon synthesis. This is because, being new, ITRA

centers are free of the factors that in traditional contexts require realigning of administrative and other organizational boundaries. Proposed ITRA centers would bring together researchers in all of these disciplines under the same unit. This, combined with the encouragement (albeit not a uniform, essential requirement), of team based mode of research can be expected to lead to fundamental advances, normally associated with deeply theoretical work. Simultaneously, the theory would have been motivated by more diverse practical constraints than is normal, combining elegance with applicability. Interdisciplinarity these days is a much appreciated, but hard to realize, need. We therefore expect the proposed ITRA centers in this focus area will make their worldwide mark right from the start, from their formation itself, and later, of course, through the natural uniqueness of the work they produce.

ITRA focus on mobile devices, in the proposed interdisciplinary way, can therefore be expected to not only put India on the “science” and “fundamental advances” map of the world in related existing areas, but should also translate into unique new hybrid disciplines, teams and entrepreneurial activities.

Following the aforesaid team selection mechanism, 9 team projects consisting of 34 institutions, were identified under the focus area with approval of Hon’ble MCIT. These nine projects were further classified into three clusters. The projects within each cluster share a theme, of Mobile Computing and Networking applied to one of three different application domains, namely, (i) Transportation, (ii) Healthcare and (iii) Disaster Management. The teams within any of these clusters have domain specific similarities, even though the problems they address are different. Collaboration among teams within a cluster typically stronger than across clusters although not always as strong as within teams. List of projects in the focus areas is placed at ANNEXURE 7.

Status / Achievements made so-far by the teams of ITRA-Mobile is as follows:

1. **Initial Scale:**

- # LIN & PIN - **34**
- # Pyralets - **11**

2. **Research Eco system in place**

- # of faculty members = **59**
- # students = **156**
- # Ph D students = **76**
- # of research collaborators from overseas Univ = **9**
- # of Mentors and Advisors = **26**
- # of Collaborators (Govt dept, NGO, Industry)=**22**

3. **Significant Rooting in Societal Challenges**

- Sensing of Energy and Health Data, and Control
- Post-Disaster Management
- Communication among and with Fishermen at Sea
- Delivery of Health Services in Remote Areas
- Mobile Assistant using Voice and Gestures
- Decongesting India’s transportation.

4. **Research Output**

- # Ph D students = **76**
- # of Papers (Conferences & Journals) = **99**
- # of Patents = **Nil**



## 5. *Research Impact*

### *On Curriculum*

- 8 new course modules have been introduced in different institutions associated with ITRA-Mobile.
- 2 course modules were upgraded in different institutions associated with ITRA-Mobile.
- Developed a courseware in Wireless Sensor Networks/Mobile Sensing at SHIV NADAR University
- Introduced the topic of interfacing external sensors with mobile phones, in the Mobile Computing Course offered in the Monsoon semester at IIIT Delhi
- A course module on spatial data analysis using GIS.
- New course on “Programming Cloud Services for Mobile Applications” has been developed and is being offered.
- A course module on Data Provenance is added at IIIT-Delhi
- Amrita University added a module on Cognitive Radio in Advanced Wireless Course.
- Amrita University also added a module on small cell network in Mobile Communication course.
- A new course offered at IRPE on Advanced communication with introduction to cognitive radio for M Tech.
- A new course is offered on Software Defined Radio at NIITU.

### *On Research Facilities*

- Test-bed at the nodal center/research lab with a few USRP (Universal Software Radio Peripheral) boxes and computers equipped with GNURadio will be the initial experimental setup on which basic wireless communication examples can be carried out.
- A refresher course is planned be organized for methodologies in teaching telecommunication subjects, with hands on training on the USRP based test-bed under the “uncoordinated project”. This will particularly target teachers from rural and semi-urban technical institutes.
- DiSARM is developing a test-bed using low-cost computing devices for testing mobile architecture. The team developed an end-to-end system and tested it extensively on various places like department, outdoor market stores, shopping malls and disaster prone areas.
- 7 new mobile research labs have been established in the institutions involved in the ITRA-Mobile project.
- 4 Labs in the institutions taking part in the ITRA-Mobile initiative have been upgraded to further their research capacity in mobile computing, networks and applications
- LTE simulation module for QualNet simulation platform..

## 6. *Technology Development*

- Remote Health Kiosks in Bengal
- Efficient Energy Management in Delhi
- Transportation Systems for Chandigarh Roads
- Providing Post-disaster Services using Rapidly Deployed Devices to Establish Communication in (Disruption-Prone) Networks
- Mobile Infrastructure for Fishing Boats Off the Coast of Tamilnadu.

## 7. *Outreach*

- # of summer, winter and monsoon schools – **12**
- # of participants – **800**
- # of short and long courses at conferences – **4**
- # of tutorial at conferences – **3**
- # of participants to above courses – **300**
- # of seminar series – **3**
- # of participant to above series – **50**

- # of collaborators ( Govt dept, industry, NGO) - **22**
- # of Industry interactions - **9**

#### 8. *Technology Transfer/ Collaborations*

- Healthcare Kiosks
- Punjab State Departments (Transportation)
- Tamilnadu Fishermen.

#### 9. *Geographies Covered & Leading Institutes:*

- NORTH INDIA – Delhi, Jaipur, Chandigarh, Lucknow (IIT D, IIITD)
- SOUTH INDIA –Thiruvananthapuram, Kollam, Hyderabad, Karimnagar, Bangalore (IIT M, IIM B, IIITH, Amrita)
- EAST INDIA – Kharagpur, Kolkata, Durgapur, Bhuvaneshwar (IITKGP, IIMC, IRPE, KIITU, Jadavpur University, NIT Durgapur)
- WEST INDIA – Mumbai (IIT B, TIFR)

### **ITRA-Water**

The Strategy Formulation Meeting (SFM) for the area *IT based Innovations in Water Resources Sustainability* held during September 28-30, 2011. The meeting was organized to identify, discuss and develop a research and development agenda focusing on this area. The meeting was attended by participants from academia, government, industry and NGOs, from India as well as abroad. Based on this meeting a Request for Proposal document was created.

ITRA-Water is focused on the challenge of sustainable access to water – which is a problem reaching crisis proportions across India. Water will become the bottleneck for the economic growth of the country affecting all sectors including food and agriculture, industry, energy, and human health. This is a multifaceted challenge and it involves rapidly declining water quantity and quality in surface and groundwater resources, extremely variable distribution in space and time affecting availability and access, and devastating consequences of floods and droughts driven by the uncertainty of the strength and timing of the monsoon system. The demand for water driven by agriculture, industrial, consumptive and livestock needs is increasing rapidly. This is further compounded by the effects of climate change that is increasing glacier melt rates, changing frequencies of floods and droughts, and impacting the natural and human demand for water. The solution of water issues requires consideration of water, energy, food and human health as an integrated problem. Human rights and social justice are also an integral part of the solution needs. Significant progress can be made by enabling locally informed, locally relevant and market efficient solutions through empowerment of the community that is blended/overlaid with centrally planned and policy driven solutions.

The SFM identified four grand challenges in the area of Water Resources Sustainability using IT:

- i.) Improving hydro-meteorological prediction for economic development,
- ii.) Improving groundwater levels and quality through enhanced water use efficiency in agriculture,
- iii.) Total urban water management to achieve 24/7 availability, and
- iv.) Inter-basin water transfer for integrated water resource management.

These grand challenges are to be addressed using multi-institution collaboratives. In this context, IT is interpreted broadly as cyberinfrastructure to include communication, computational, and collaborative technologies; sensors and sensor systems; data management and data mining technologies; and knowledge and decision support systems. ITRA-Water will serve as a catalyst for developing scientific and IT

capacity through a paradigm shift in educational and training modalities, as well as support economic and policy solutions to foster multifaceted, comprehensive and sustainable solutions to present and emerging water challenges. ITRA-Water envisions open sharing of data, model and information as a core value for progress; and considers innovative and imaginative inter-disciplinary cross sector collaboration across educational, private and government institutions, NGOs, national laboratories, etc., as being essential for addressing the water challenge.

Following the aforesaid team selection mechanism, 5 team projects consisting of 20 institutions, were identified under the focus area with approval of Hon’ble MCIT. These projects were further classified into four clusters. The proposals within each cluster share a theme, of IT Based Innovation in Water Resources Sustainability, applied to one of four different application domains, namely, (i) Improving groundwater levels and quality through enhanced water use efficiency in agriculture; (ii) Total urban water management to achieve 24/7 availability. The teams within any of these clusters have domain specific similarities, even though the problems they address are different. . The teams within any of these clusters have domain specific similarities, even though the problems they address are different. Collaboration among teams within a cluster typically stronger than across clusters although not always as strong as within teams. List of projects in the focus areas is placed at ANNEXURE 8.

Status / Achievements made so-far by the teams of ITRA-Water is as follows:

1. **Initial Scale:**

- # LIN & PIN - **20**
- # Pyralets - **6**

2. **Research Eco system in place**

- # of faculty members = **31**
- # students = **75**
- # Ph.D students = **27**
- # of research collaborators from overseas Univ = **5**
- # of Mentors and Advisors = **17**
- # of Collaborators (Govt. dept., NGO, Industry) = **24**

3. **Significant Rooting in Societal Challenges**

- Orange growers’ water & disease problem in Vidarbha
- Urban Flood issues in cities.
- Water contamination and water loss problem in water pipe network.
- Ground water level going down.
- Water is not used efficiently for agriculture.

4. **Research Output**

- # Ph D students = **27**
- # of Papers (Conferences & Journals) = **37**
- # of Patents = Nil

5. **Research Impact**

**On Curriculum**

- At IISc, the existing elective course on “Urban Hydrology” has been extensively modified.
- A new elective “Urban Hydrology” at Masters Level has been introduced at BIT Pilani at Hyderabad.
- Rural Informatics: New modules have been introduced.

- Geospatial Interoperability and Knowledge Discovery: The module on Sensor Web of this course has been enhanced.
- IITH- M.Tech course on Ground Water modelling: This course will introduce new components such as Hydro-geologic characterization & Aquifer Mapping at Village scale.
- Univ of Hyderabad revamped two laboratory courses and one elective course.
- At IIT Kharagpur a short term course on Geospatial Technologies for Hydrological Modelling was conducted for students, teachers and researchers from different organizations/universities of the country.

#### ***On Research Facilities***

- # of new labs – 7
- # of labs updated in a major way – 6
- 3 in situ test beds for continuous monitoring of groundwater level and quality, major weather parameters, and soil moisture from different layers in the root zone using sensor technology were developed.
- A water level measurement test bed is formed using ultrasonic sensors in the lab at IISc.

#### **6. *Technology Development***

- A novel plug and play integrated field sensors platform (open source hardware and software) called the SenseTube has been developed and three units have been deployed in the field.
- An Aquafer Mapping service has been demonstrated.
- A multi-purpose integrated system prototype is developed to monitor the quality and quantity of water flow in different scenarios mainly focused on drinking water.
- Water management studies on finger millet during summer in mid land situation have been conducted probably for the first time in India. This experiment definitely provides valuable information regarding water demanded of finger millet. Finger millet may prove best option for replacing the summer rice.
- Mobile based drought prediction system was developed by M2M team and tested in Gujarat.
- A lab prototype of unmanned data collector using aerial vehicle from the sensor node has been tested.

#### **7. *Outreach***

- # of summer, winter and monsoon schools – 6
- # of participants – 127
- # of short and long courses at conferences – 3
- # of participants to above courses – 80
- # of tutorial at conferences – 2
- # of seminar series – 6
- # of participant to above series – 50.
- # of open houses to demonstrate work to public – 2
- #of other institutes impacted – 6
- # of collaborators ( Govt dept, industry, NGO) - 24

#### **8. *Technology Transfer/ Collaborations***

- SENSETUBE – Possible solution & services business incubation at IIT Bombay
- Business incubation for Aquifer Mapping – in process
- Business incubation for Unmanned Vehicle for Agriculture data collection – in process
- Mobile based drought monitoring service – Government agency to be aligned.
- Urban Flood Management – DSS for Karnataka Disaster Management organization.
- Aquasense – DSS for Hyderabad Municipal Corporation.

#### **9. *Geographies Covered & Leading Institutes:***

- SOUTH INDIA – Hyderabad, Karimnagar, Bangalore (IIT H, IIITH, UoH, IISc)

- EAST INDIA – Kharagpur, Itanagar, Sambalpur, Bhubaneswar (IITKGP, IITBHU)  
WEST INDIA – Mumbai, Amravati, Ahmedabad, Godhra, Raipur (IITB, IITG)

## **ITRA-Ag&Food**

SFM for the area *IT based Transformations in Indian Agriculture and Food* held during March 15-16, 2013, in collaboration with the Indian Council of Agricultural Research (ICAR). The meeting was organized to develop a plan of research and development towards realizing large scale field use of IT in agriculture and food in India. The meeting was attended by participants from academia, government, industry and NGOs, from India as well as abroad. Based on this meeting a Request for Proposal document was created.

Prime aim of ITRA-Ag&Food is create collaborative, multi-institutional, inter-disciplinary teams to catapult the state of Agriculture & Food (Ag&Food) into a new orbit of productivity using IT. IT here may be interpreted broadly as cyber-infrastructure that would help enable the desired paradigm shift in Ag&Food, by integrating into Ag&Food operations capabilities such as environment and location sensing, communication, data management, modeling, simulation and data mining. The work under this initiative, primarily focused on inter-disciplinary R&D on current and emerging Ag&Food challenges with the necessary cross sector (e.g., among IT, Ag&Food, etc.) collaboration, will be expected to simultaneously impact educational and training modalities, demonstrate that Ag&Food are an important arena for advanced and creative IT activity with much societal returns and satisfaction, and enable a range of entrepreneurial and other outreach activities. Given that a significant fraction of the work in the Ag&Food field tends to have high degree of applicability in relatively short term, and given the scale of the field, the impact can be very significant, the proposals are expected to lay out clearly how the proposed work is going to integrate outreach activities to make a major field impact. The outreach activities include development of IT-driven Ag&Food systems designed by IT and Ag&Food experts, from government, academic, research, industrial, non-governmental and extension organizations. Another important outcome of the outreach part is economic and policy approaches conducive to the multifaceted, comprehensive and sustainable solutions targeted by the R&D work. Given two otherwise comparable proposals, the one that has a larger role for IT in it will be given preference.

The following examples of IT based interventions are likely to lead to an increase in Ag&Food productivity: IT can help the average Indian farmer obtain relevant information on markets, inputs, technologies and financing; IT can help in bridging the knowledge gap as it permits geographically distributed organizations to work together more effectively, allowing them to provide mutual mentorship and support; IT can link agricultural producers to increasingly globalized production chains and help develop trade opportunities; and IT can support taking the long-term view, with tools for understanding and planning the future effects of today's economic and land use decisions.

Significant research advances are taking place in IT (data management, information systems, communication, sensor networks, modeling and simulation, data mining, etc.) and agriculture (green house technologies; high yielding, climate resistant and draught resistant varieties; new storage techniques; etc.). IT and agricultural researchers are both making independent and isolated efforts. The current need is to start collaborative projects carried out by interdisciplinary teams consisting of researchers from agricultural and IT sectors.

Succinctly, what is needed is a large number of institutions – faculty and PhD students - collaborating intensely on advanced research and development motivated by specific challenges faced in the field. These teams should simultaneously develop and improve curriculum on a regular basis. For creatively identifying and formulating problems, the team members need to develop an awareness of them in daily life. Finally, there need to be effective mechanisms to enable transfer of the technologies to real world.

The agriculture and food problems are listed under five categories: crop production; soil, water and weather; agriculture education and extension; marketing and agri-business; and livestock and fisheries. In this section we give a brief description of each category and provide a list of corresponding problems.

- (i) **Crop Production:** Under this category we consider production related issues pertaining to cereals, pulses, fruits, vegetables, spices, flowers, oilseeds, etc. The topics under crop production include seed production systems and planting material, crop production systems, protected cultivation, farm mechanization, farm management, precision farming, pest/disease management, biotic stress management, post harvesting management and food processing systems.
- (ii) **Soil, Water, and Weather:** This category covers issues concerning better management of soil, soil mapping, weather forecasting, abiotic stresses, environment management, disaster management, and natural resources management.
- (iii) **Agriculture education and extension:** We must cultivate the next generation of students', scientists', and professionals' practical and advanced research skills. Related goals are extending crop technologies to stakeholders (including farmers), reducing the lab to land gap, improving capacity building/training of stakeholders, providing real-time advisory to farmers, and establishing farmer expert connectivity.
- (iv) **Marketing and agri-business:** The areas include efficient procurement, storage and supply of quality agricultural produce and processed goods to consumers, sale of produce by farmers, market intelligence, etc.
- (v) **Livestock and fisheries:** This category is about scientific herd/flock management, management of semen stations and information on availability of semen, milk collection, storage and processing; production and availability of fish seed; marketing of fish and aquaculture produce; marine fishing and logistics; fish processing; and production, protection, education, extension, and marketing of animals and animal products.

ITRA floated Request for Proposals (RFP) for ITRA-Ag&Food initiative in Nov 2014, for which more than 200 Expressions of Interest (EOIs) were received by February 1, 2015, the deadline. Currently, ITRA has identified 26 EoI teams for submitting full proposal.

## **ITRA-HuSim**

ITRA, in coordination with DBT, conducted SFM during January 15-17, 2015, to develop a roadmap for Human Simulator for Amyloids related Diseases. The SFM was conducted with participation of about 50 eminent IT researchers, health scientists and clinicians. SFM identified challenges associated with the understanding of the proteins called amyloids that have been implicated in a variety of diseases, including Neurodegenerative diseases, Type 2 Diabetes, Steatohepatitis and various other diseases. These diseases are expected to be the cause of a significant burden in the coming decades. SFM discussed the impact of amyloids, amyloid precursors and Mallory Body proteins on the human body, and their roles in the aforementioned diseases. These proteins are known to misfold and form plaques and aggregates under certain conditions. The major organs impacted include, the brain, liver, kidney, and pancreas. SFM concluded that the understanding of the formation, transport, misfolding and plaque formation mechanisms, and their impact on the organs will vastly increase our ability to successfully treat the diseases caused by the proteins. Specifically, the SFM participants were asked to identify the mechanisms

and modeling and clinical treatment options that should be investigated under ITRA-HuSim. Based on this meeting a Request for Proposal document was created. The basic objective of the focus area of ITRA-Human Simulator is to address the most important challenges being faced by the clinicians today, by furthering the therapeutic options available to them and their efficiency at analyzing them. Clinicians must often assemble their reasoning from answers to specific questions that arise along the way. Finding clear answers to some of them may be relatively straight forward but slow. A central objective of the simulators being targeted here is to carry out the corresponding low level tasks, and shoot back the required intermediate information readily as the clinician focuses on the big picture.

With respect to a specific clinician, the simulators will help with a specific type of disease or a family D of diseases. The scope of this RFP is on chronic diseases most associated with Amyloid and Amyloid-like proteins, and known to have a large burden. Proposals should be directed primarily at the set of diseases  $D = \{\text{Alzheimer's, Parkinson's, Frontal Temporal Dementia, Steatohepatitis, Diabetes-II, Amyloids related Nephritis}\}$ , which can affect the brain, liver, Pancreas and Kidney.

A simulator will help a clinician model disease related processes and interventions. It would model a specific body process, and help find answers to questions in silico without running actual experiments on humans or animals. The process modeled may be of different types. It may: (i) be confined to one or multiple organs; (ii) involve body phenomena of different types, e.g., corresponding to biochemical, pharmacological, anatomical, tissue-geometric and vascular; (iii) have different scopes, e.g., pathways; and (iii) capture body behaviors at the levels of molecule, cell, organ, organism, or an entire population.

With the simulator, a clinician may be able to try out different hypotheses about a process. Since a disease is a combination of many types of processes, an appropriately assembled network of simulators will help identify and integrate different types of available information pertaining to a disease and develop a model for its state. The clinician may reconstruct the condition of a particular patient with a specific disease and experiment with it, e.g., with different options available for diagnosis; therapy; prognosis; prevention; and intervention by drugs, novel agents, drug combinations, dose-time protocols and prediction of risks associated with them. The network may thus function as an in-silico clinical trial platform.

ITRA floated RFP for ITRA-HuSim initiative in March 2015, for which 32 EoIs were received by April 19, 2015, the deadline. Currently, ITRA is processing the EoIs.

## ITRA Activities, Milestones and Achievements

### Activities undertaken by ITRA: 2010 – 2015

Legend:

	Administrative activities undertaken by ITRA
	Technical activities undertaken by ITRA

Timeline	Activity/ Milestones	Output
Oct 2010	Admin approval for ITRA project, given to MLAsia	→ Admin Approval given to MLAsia, and asked to complete the administrative formalities.
Dec 2010	Release of 1 <sup>st</sup> instalment of funds	→ Rs. 14.33 Crs as 1 <sup>st</sup> instalment was released to MLAsia for ITRA project → Commencement of ITRA project as per DeitY's Admin Approval
Mar 2011	Constitution of Program Steering and Implementation Group (PSIG)	→ PSIG constituted with approval of Hon'ble MCIT with following members: (i.) Prof. N. Ahuja, UIUC USA; (ii.) Dr U.P. Phadke, DeitY (retd.); (iii.) Mr V.B. Taneja, DeitY (retd.); (iv.) Prof. R, Sangal, IIIT Hyd; (v.) Dr G. V. Ramaraju, DeitY Representative. → Terms of appointment were finalised and approved.
June 2011	Formal Start of ITRA Technical Activities	→ Technical activities started in ITRA post joining of Prof Ahuja as Member and Co-ordinator of PSIG
Jun - Sep 2011	Technical activities by PSIG	→ PSIG interacted with various DeitY R&D groups to identify the complimentary role that can be played by ITRA in strengthening ICT eco system. → 2 Focus Areas were identified, viz, ITRA-Mobile: Mobile computing, Networking and Architecture, and ITRA-Water: IT Based Innovations in Sustainability of Water Resources.
Jun - Sep 2011	Administrative activities by PSIG	→ Mechanisms to initiate project activities were formulated and implemented → Constitution of the Governing Council (GC) and Advisory Council (AC) finalised and processed for approval → Planning and Actions on administrative matters, viz. Office Space, Recruitment, etc. → Planning of Strategy Formulation Meeting (SFM) for the selected focus areas.
Sep 2011	SFM on ITRA-Water	→ The meeting was attended by 50+ experts from academia, government and industry, from India as well as abroad. This SFM identified the following themes: → Improving Hydro-Meteorological Prediction for Economic Development → Improving Groundwater Levels and Quality Through Enhanced Water Use Efficiency in Agriculture → Total Urban Water Management to Achieve 24/7 Availability → Inter-basin water transfer for integrated water resource management.



Oct 2011	SFM on ITRA-Mobile	<ul style="list-style-type: none"> <li>→ The meeting was attended by 50+ participants from academia, government and industry, from India as well as abroad. This SFM identified the following themes:</li> <li>→ Communication Theory</li> <li>→ Network Theory</li> <li>→ Graph Theory</li> <li>→ Dependable Systems</li> <li>→ Communication Protocols</li> <li>→ Operating Systems</li> </ul>
Dec 2011	RFP's floated for ITRA-Water and ITRA-Mobile	→ Requests for Proposals (RFP) for both focus areas were prepared and circulated.
Jan 2012	Constitution of ITRA – GC and AC	<ul style="list-style-type: none"> <li>→ ITRA GC was setup with the approval of Hon'ble MCIT and is chaired by the Secretary, DeitY. The GC has representatives from MHRD, Academia, and Industry. ITRA GC provides general guidance and supervision. It has full powers to decide and approve various policy matters of the ITRA.</li> <li>→ ITRA AC was setup with the approval of Hon'ble MCIT and is chaired by Prof. S. V. Raghavan, Scientific Secretary, Office of the Principal Scientific Advisor to the Government of India. The AC consist of eminent persons and visionaries from IT, IT-in-X and related policy-making areas and from other disciplines of relevance.</li> </ul>
Feb – Apr 2012	Processing of proposals submitted for ITRA-Mobile and ITRA-Water	<ul style="list-style-type: none"> <li>→ The last dates of receiving Expression of Interests was end of Jan 2012.</li> <li>→ For ITRA-Water – 30 EoIs and for ITRA-Mobile – 64 EoIs were submitted by deadline.</li> <li>→ EoIs were reviewed by experts and shortlisting of teams to submit Full Proposals (FP) was done: for Water 20 Teams; and for Mobile 30 Teams were shortlisted.</li> </ul>
Apr 2012	Meeting of ITRA AC	<ul style="list-style-type: none"> <li>→ Ratification of the areas already initiated: ITRA-Mobile and ITRA-Water</li> <li>→ Probable candidates for new focus areas presented</li> <li>→ Food and Agriculture domain was recommended</li> </ul>
May – Oct 2012	Processing of proposals submitted for ITRA-Mobile and ITRA-Water	<ul style="list-style-type: none"> <li>→ FP Submissions were due in late May 2012 for both Mobile and Water</li> <li>→ Review of FPs was done online by experts;</li> <li>→ Teams were asked to incorporate comments of the experts and re-submit their FPs by Oct 2012.</li> </ul>
Feb – Sep 2012	Drafting Technical/Administrative/Financial guidelines/policies for ITRA	<ul style="list-style-type: none"> <li>→ PSIG drafted guidelines for Selection of Focus Areas; Proposal Submission, and Evaluation &amp; Award Processes.</li> <li>→ Policy documents specifying recruitment rules and organizational structure were also drafted.</li> </ul>
Oct 2012	Meeting of ITRA GC	→ Various policies / guidelines as drafted by PSIG were approved in this meeting.

Nov 2012	Review Panel Meeting of ITRA-Mobile FP	→ Review Panel shortlisted 10 proposals for further processing and further classified each proposal in one of three different application domains, namely, (i) Transportation, (ii) Healthcare and (iii) Disaster Management.
Jan 2013	Brainstorming meeting on Ag&Food	→ Meeting was conducted on the subject of IT in Agriculture and Food with various scientists/faculty from ICAR, IIIT-H, UIUC, Ministry of Agriculture, etc. → White Paper was prepared to articulate some of the problems faced by the Indian Agriculture and Food sector. → Roadmap and probable list of attendees for the SFM was drafted.
Jan 2013	Constitution of ITRA EC	→ ITRA EC was setup with approval of ITRA GC and is chaired by Director-ITRA. This committee takes all decisions needed to implement the approved policies. Overall, EC will provide guidance to ITRA for effective execution of the programme.
Feb 2013	Review Panel Meeting of ITRA-Water FP	→ Review Panel shortlisted 9 proposals for further processing and further classified each proposal in one of four different clusters (i) Improving hydro-meteorological prediction for economic development (ii) Improving groundwater levels and quality through enhanced water use efficiency in agriculture; (iii) Total urban water management to achieve 24/7 availability; and (iv) Assessment and intervention.
Mar 2013	Meeting of ITRA EC	→ PIs of shortlisted ITRA-Mobile and Water projects presented their proposal. → EC recommended some technical/ financial modifications and resubmit FPs
Mar 2013	SFM on <i>ITRA-Ag&amp;Food</i>	→ SFM was attended by 80+ National and International IT, Agriculture and food experts. This SFM identified the following themes where IT can intervene: → Crop production; → Soil, water and weather; → Agriculture education and extension; → Marketing and agri-business; and → Livestock and fisheries
May 2013	Meeting of ITRA EC	→ PIs of shortlisted ITRA-Water projects presented their proposal. → EC recommended some technical/ financial modifications and resubmit FPs → Recommended 9 Mobile and 7 Water projects for award
May-July 2013	Brainstorming meetings on various probable focus areas	→ Brain storming meeting on ITRA-BIO: ACQUISITION, UNDERSTANDING AND APPLICATION OF BIOMEDICAL DATA was conducted on May 29, 2013 at New Delhi which was attended by 10 domain experts to prepare a white paper on the subject. → ITRA in collaboration with IISc organised a meeting on CHALLENGES IN GENOMICS AND COMPUTING during July 22-24, 2013 at Bangalore. This meeting was attended by more than 50 national and international domain experts.

July, 2013	Meeting of ITRA AC	<ul style="list-style-type: none"> <li>→ 7 new probable focus areas were presented.</li> <li>→ AC prioritised those areas</li> <li>→ AC suggested that ITRA pick two areas to pursue in the near future, the rest to be considered subsequently.</li> </ul>
Sep 2013	Brainstorming meetings on various probable focus areas	<ul style="list-style-type: none"> <li>→ Brain storming meeting on ROBUST ELECTRONICS was conducted on Sep 24, 2013 at New Delhi which was attended by 10 domain experts to prepare a white paper on the subject.</li> <li>→ Brain storming meeting on COMPUTATIONAL FLUID DYNAMICS was conducted on Sep 27, 2013 at New Delhi which was attended by 10 domain experts to prepare a white paper on the subject.</li> </ul>
Sep 2013	Award of Projects	<ul style="list-style-type: none"> <li>→ 14 team projects worth Rs. 39 Crs were awarded with the approved of Hon'ble MCIT.</li> <li>→ In <i>ITRA-Mobile</i>, 9 teams, consisting of 34 institutions, and in <i>ITRA-Water</i>, 5 teams, consisting of 20 institutions, were awarded projects.</li> </ul>
Oct 2013	Release of second instalment of funds to ITRA	<ul style="list-style-type: none"> <li>→ Rs. 16.27 Crs were released to MLAsia as second instalment of funds for ITRA projects.</li> </ul>
Nov 2013	Policy for post project award engagement with teams	<ul style="list-style-type: none"> <li>→ Meeting to draft framework for post project award engagements with teams was conducted. This was attended by around 10 experts mainly from Govt., and academia.</li> <li>→ Subsequently framework was framed for <ul style="list-style-type: none"> <li>→ ITRA Awards for students and teams</li> <li>→ Interactions of ITRA Teams with Mentors</li> <li>→ International Travel of ITRA Researchers</li> <li>→ Adjunct Faculty Scheme</li> <li>→ Attracting New Faculty</li> </ul> </li> </ul>
Dec 2013	Meeting of ITRA AC	<ul style="list-style-type: none"> <li>→ Two themes of national significance and need that may run through the detailed topics recommended at the 2<sup>nd</sup> AC meeting were discussed.</li> <li>→ Two overarching focus areas, viz. Human Simulator and Diagnostic Dome, that unify several of the recommended topics, were identified and proposed to be pursued by ITRA.</li> </ul>
Dec 2013	Meeting of ITRA EC	<ul style="list-style-type: none"> <li>→ 3<sup>rd</sup> meeting convened to plan ITRA project launch workshop and discuss ITRA's extension.</li> </ul>
Jan 2014	Formal launch of <i>ITRA-Mobile</i> and <i>ITRA-Water</i> Projects	<ul style="list-style-type: none"> <li>→ 14 team multi-disciplinary, collaborative, multi-institutional R&amp;D projects in the areas of "Mobile Computing, Networking and Applications (<i>ITRA-Mobile</i>)" and "IT based Innovations in Sustainability of Water Resources (<i>ITRA-Water</i>)" were launched.</li> <li>→ All teams were briefed about ITRA's objectives, and methodology.</li> </ul>
Apr 2014	Meeting of ITRA GC	<ul style="list-style-type: none"> <li>→ Draft policy for post project award engagement with teams, ITRA extension, and new focus areas, were presented in the 2<sup>nd</sup> meeting of GC.</li> </ul>

		→ A sub-committee was constituted for formulating the policy for post project award engagement with teams.
May - July 2014	Meeting of Sub-committee of GC	<ul style="list-style-type: none"> <li>→ Sub-committee drafted the schemes and policies for: <ul style="list-style-type: none"> <li>→ UG and PG Student Internships</li> <li>→ Performance Based Awards for Students and Teams</li> <li>→ Interactions of Teams with Mentors</li> <li>→ International Travel of Researchers</li> <li>→ Interactions of Teams with Adjunct Faculty</li> </ul> </li> <li>→ Approved by Chairman – GC in Aug 2014</li> <li>→ Approval of DeitY was sought for implementation of the same in Aug 2014.</li> <li>→ IFD/DeitY recommended to seek approval in ITRA GC's next meeting</li> </ul>
Aug 2014	Feedback Workshops of ITRA-Water and ITRA-Mobile projects	<ul style="list-style-type: none"> <li>→ Feedback workshop held in Bangalore to review and provide feedback to ITRA–Water teams.</li> <li>→ Feedback workshop held in Delhi to review and provide feedback to ITRA–Mobile teams.</li> </ul>
Oct 2014	Meeting of ITRA GC	<ul style="list-style-type: none"> <li>→ 3<sup>rd</sup> meeting of ITRA GC convened to seek approval on various schemes and policies, ITRA extension, plans for initiating two new focus areas, and external funding opportunities</li> <li>→ All schemes and policies were approved.</li> <li>→ Recommended to seek one-time dispensation of Dept. of Expenditure for all international travel.</li> <li>→ Recommended mid-term review of the functioning of ITRA, before seeking extension.</li> <li>→ Approved plans for new focus area.</li> <li>→ Asked ITRA to constitute a committee to formulate policy on external funding.</li> </ul>
Oct 2014	Meeting of PRSG	<ul style="list-style-type: none"> <li>→ PRSG for ITRA project constituted by DeitY under chairmanship of Prof UB Desai, Director, IIT Hyd</li> <li>→ 1<sup>st</sup> meeting convened to oversee the progress of ITRA.</li> <li>→ PRSG recommended the following: <ul style="list-style-type: none"> <li>→ Revise targets of PhD students to 250 instead of 480.</li> <li>→ Seek approval on international travel of ITRA researchers from PRSG on case to case basis</li> <li>→ Release 30 Crs to MLAsia as next instalment of ITRA project.</li> </ul> </li> </ul>
Nov 2014	Brainstorming Meeting for <i>ITRA-HuSim</i>	→ Brainstorming was conducted to develop an outline of the Human Simulator initiative of ITRA – in terms of defining its scope, and identifying the sciences, engineering disciplines, stakeholders, organizations, individuals, etc., to be involved to best realize that

		scope. This meeting was attended by around 15 eminent experts from Govt. departments, Research Institutions, Academia and Industry.
Nov 2014	RFP for <i>ITRA-Ag&amp;Food</i>	→ RFP for the focus areas were prepared and circulated.
Dec 2015	Meeting of ITRA EC	→ 4 <sup>th</sup> meeting convened to discuss (i) Addition of new PINs to the existing teams; (ii) To formalize eligibility criteria for Indian Academic Institutions in line with DeitY's PhD Scheme; (iii) Revisiting permissible budget heads for private institutions → EC recommended the following: → Seek recommendations of Review Panel on New PINs during Evaluation Workshop → Agreed to suggestions as made by ITRA on eligibility criteria with some modifications. → Agreed to release of Contingencies and Misc budget head to private institutions.
Jan 2015	Evaluation Workshop for ITRA-Mobile and ITRA-Water	→ The Annual Evaluation Meeting of ITRA-Water and ITRA-Mobile was conducted in January, 2015. → 14 team projects were reviewed by panels of 10 to 15 experts in the respective fields. Students presented posters for their respective projects. → A total of 72 posters (33 for ITRA-Water and 39 for ITRA-Mobile projects) were presented during the course of the workshop. → Based on the evaluations, the following awards were announced: → PhD Research Award at Exemplary level – 1 PhD student → PhD Research Award at Outstanding level – 13 PhD students → PhD Dissertation Award at Outstanding level – 1 PhD student → Team Achievement Award at Exemplary level – 1 team (4 institutions) → Team Achievement Award at Outstanding level – 2 team (10 institutions) → Partnership Award at Outstanding level – 5 LIN-PIN pairs (10 institutions) → Partnership Award at Exemplary level – 1 LIN-PIN pairs (2 institutions)
Jan 2015	SFM for <i>ITRA-HuSim</i>	→ SFM on 'Human Simulator for Amyloids related Diseases ( <i>ITRA-HuSim</i> )' was conducted in January, 2015. More than 60 international and national experts, from the fields of Medicine as well as ICT&E participated in the meeting.
Feb – May 2015	Processing of proposals submitted for <i>ITRA-Ag&amp;Food</i>	→ 200+ EOIs received by deadline of Feb 1, 2015. → 18 EOI shortlisted for FP stage in Apr 2015. → Workshop for development of FP by the shortlisted EOI teams planned for May 15-16, 2015.
Mar 2015	RFP for ITRA-HuSim	→ RFP for the focus areas were prepared and circulated.
Mar 2015	Release of 3 <sup>rd</sup> instalment to ITRA	→ Rs. 8 Crs were released to MLAsia as third instalment of funds for ITRA projects.

Apr 2015	Meeting of PRSG	<p>→ 2<sup>nd</sup> Meeting convened to discuss Status of ITRA project; Modifications in existing ITRA-Mobile and ITRA-Water teams; ITRA project extension; Interaction and collaboration with UNESCO.</p> <p>→ PRSG recommended the following:</p> <ul style="list-style-type: none"> <li>→ endorsed the recommendation of the evaluation Workshop held in January 2015 under the aegis of ITRA regarding changes/alteration in team structure</li> <li>→ to convene a PRSG meeting in May 2015 specifically for review of ITRA activities before recommending ITRA extension</li> <li>→ approved interaction and collaboration with UNESCO</li> </ul>
Apr 2015	Processing of proposals submitted for <i>ITRA-HuSim</i>	<p>→ 32 EOIs received by the deadline of Apr 19, 2015</p> <p>→ Review of EOIs under process, deadline May 19, 2015</p> <p>→ Around 20 EOI teams are anticipated be called for developing FP.</p>

### Current Status vis-a-viz DPR Targets

Parameter	Final Target (DPR)	Achieved
<b>Participating Institutions</b>	<b>40</b>	<b>44</b>
<b>Large Research Institutions</b>	<b>20</b>	<b>17</b>
<b>Small Research Institutions</b>	<b>40</b>	<b>37</b>
<b>ITRA Faculty</b>	<b>74</b>	<b>80</b>
<b>Adjunct Faculty</b>	<b>51</b>	<b>0</b>
<b>PhD Students (Students and Lecturers)</b>	<b>250*</b>	<b>103</b>

\* Targets revised by PRSG from 480 to 250

### Achievements

1. ITRA Model in place & Delivering Results.
  - LIN & PIN - 54
  - Pyralets - 17
2. **Teams are Diverse**
  - # of faculty members - **80**

- # students - **231**
  - # Ph D students = **103**
  - # of research collaborators from overseas Univ = **14**
  - # of Mentors and Advisors (M 26 + W 17) = **43**
  - # of Collaborators (Govt dept, NGO, Industry) - **46**
3. ***Research Seeds Sown Throughout India***
- NORTH INDIA – Delhi, Jaipur, Chandigarh, Lucknow (IIT D, IIITD)
  - SOUTH INDIA – Hyderabad, Karimnagar, Bangalore (IIT H, IIITH, UoH, IISc), Thiruvananthapuram, Kollam, Hyderabad, Karimnagar, Bangalore (IIT M, IIM B, IIITH, Amrita)
  - EAST INDIA – Kharagpur, Itanagar, Sambalpur, Bhubaneswar (IITKGP, IITBHU); Kharagpur, Kolkata, Durgapur, Bhubaneswar (IITKGP, IIMC, IRPE, KIITU, Jadavpur University, NIT Durgapur)
  - WEST INDIA – Mumbai, Amravati, Ahmedabad, Godhra, Raipur (IITB, IITG); Mumbai (IIT B, TIFR)
4. ***Research Output started coming in.***
- # Ph D students = 103
  - # of Papers (Conferences & Journals) - 136
  - # of Patents - Nil
5. ***Outreach: Building & Spreading Innovation Culture***
- # of summer, winter and monsoon schools – **18**
  - # of participants - **927**
  - # of short and long courses at conferences - **7**
  - # of participants to above courses - **380**
  - # of tutorial at conferences - **5**
  - # of seminar series - **9**
  - # of participant to above series - **100**
  - # of open houses to demonstrate work to public – **5**
  - # of other institutes impacted – **15**
  - # of collaborators - **46**

## Financials

### Summary

<b>Total funds released so far by DeitY</b>	<b>Rs. 38.60 Cr</b> (Rs. 14.33 Cr in 10-11; Rs. 16.27 Cr in 13-14; and Rs. 8.00 Cr in 14-15)
<b>Interest Adjusted in release</b>	<b>Rs. 2.32</b>
<b>Total funds including Interest</b>	<b>Rs. 40.92 Cr</b>
<b>Total amount spent so far</b>	<b>Rs. 32.42 Cr</b>
<b>Balance Available</b>	<b>Rs. 8.5 Cr</b>
<b>Commitments:</b>	<b>Rs. 97.53</b>
- ITRA-Water Projects	- Rs. 20.31 Cr
- ITRA-Mobile Projects	- Rs. 17.22 Cr
- ITRA-Ag&Food Projects	- Rs. 30.00 Cr
- ITRA-HuSim Projects	- Rs. 30.00 Cr

### Head wise Break-up of Expenditure

<b>Budget head</b>	<b>Amount (in INR Lakhs)</b>
<b>1) R&amp;D Facilities &amp; Prototyping</b>	<b>2,105.80</b>
<b>2) Adjunct Faculty Salary &amp; fellowships</b>	<b>194.59</b>
<b>3) ITRA HQ, DeitY Coordination &amp; Workshops</b>	<b>567.92</b>
<b>4) Misc &amp; Contingency</b>	<b>374.00</b>
<b>Grand Total</b>	<b>3,242.31</b>



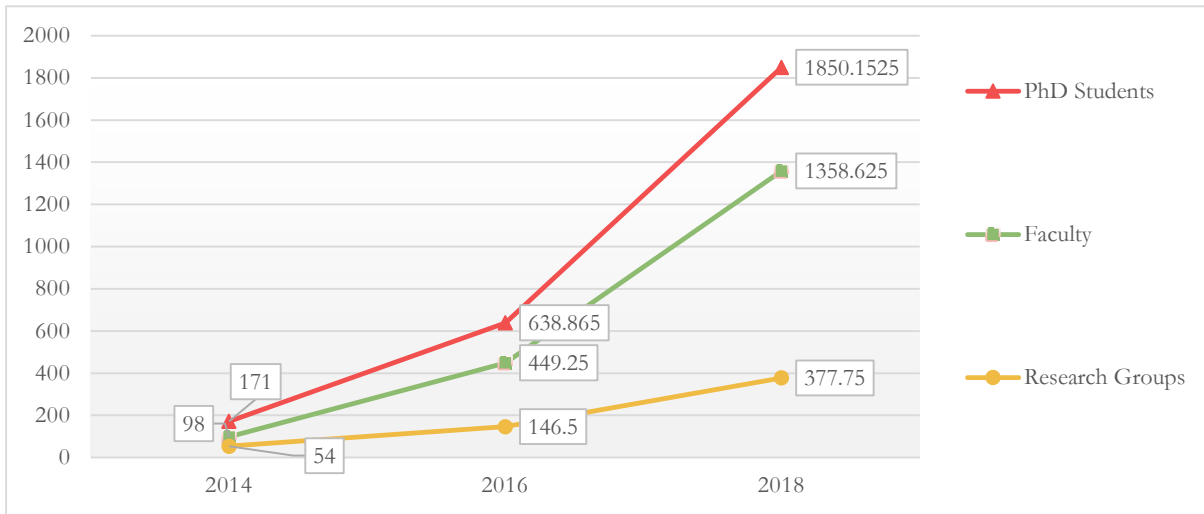
## Conclusions and Next Steps

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ITRA was set up as a seed effort to build a national resource, aimed at enhancing the quality and quantity of research Information and Communications Technologies and Electronics (ICTE, or IT for short) and its applications, in IT and related institutions across India. To that end, the ITRA model has been tested on two focus areas: ITRA-Mobile and ITRA-Water. The 1.5-year experience with these so far has helped refine many of the (i.e., early parts) of the model, but it has mainly provided an opportunity to work out the implementation details that must of necessity be determined by the implementation environment. The results of the model so far have been encouraging: the mechanisms of teamwork, inclusion of less-accomplished institutions, basic research advancement, research motivated by societal-challenges, multidisciplinary collaborations, engagement with the best researchers, inspiring and incentivizing researchers, impacting research related curricula, outreach to make an impact, engagement of technology translation agents, and geographical spread have been encouraging. The model appears to be promising.

The following directions therefore appear to be worth pursuing hereon.

1. There are some new requirements being encountered at large scale in the two focus areas being initiated currently - ITRA-Agriculture&Food and ITRA-HumanSimulator. These include large scale testing of the mechanisms to empower highly multidisciplinary but necessarily highly collaborative research between traditionally low-interaction disciplines (IT and Agriculture and Food here). One example is the co-pyralet structure introduced for this area. There are other requirements for broad horizontal collaborations, among many disciplines, e.g., among IT, Bio-Sciences, Hospitals, and Drug Development Organizations.
2. There are some concepts in the model that are yet to be encountered as they occur in the second half of the 3-year project life. These include exponential growth (adding layers to the initial pyralets), making major curricular impact, strong virtual connectivity among teams, societal development programs, and pursuing entrepreneurship opportunities. These will be encountered in the remaining years of the current four focus areas. The two focus areas are estimated to have a growth profile for two cycles as shown in the figure below. As another data point, another figure given below illustrates the growth profile for five focus areas over four cycles.
3. To scale the model up, to the list of areas that have been favorably discussed by the Advisory Council, etc., requires adding new focus areas. We have estimated that 25-focus-areas-in-5-years model will yield the following results:
  - a. 10000 PhDs enrolled (2000 PhDs/yr)
  - b. 7500 active academic researchers
  - c. 2200 active research groups, and
  - d. 200 start-ups in the making.



Items 1 and 2 above require continuation of the current ITRA project through the end of the four focus area projects. Item 3 requires that ITRA becomes a longer lasting program.

Finally, the speed of ITRA operations can grow at least 3-fold if there is autonomy in day-to-day operations including: Creating, even if temporary, ITRA positions; Filling the positions with the best matched people; Engaging experts, including foreign ones, as needed; Establishing national and international technical collaborations; and Executing approved plans on a day-to-day basis.

As per the administrative approval, the ITRA project shall come to an end on Dec 21, 2015. Given the time period over which the ITRA activities would be implemented, it is required that the time duration of ITRA project be extended by about 3 years, through March 31, 2019, including time to conclude the activities.

## **Composition of Various ITRA Committees and their Terms of Reference**

### **ITRA-Governing Council**

#### **Composition of ITRA-GC:**

1. Secretary to Government of India, DeitY (Chairman)
2. FA, DeitY
3. Addl Secretary, Higher Education, MHRD
4. Prof. R K Shevgaonkar, Director, IIT Delhi
5. Prof Rajeev Sangal, IIT(BHU) Varanasi
6. MD, MLAsia
7. President, Nasscom
8. Group Coordinator, Handling ITRA at DeitY
9. Head/DG, ITRA (Member Secretary)

#### **Terms of Reference (ToR) of ITRA GC:**

1. Operational/ Administrative Policies
2. Human Resource Policies
3. Finance Policies
4. Policies regarding engaging adjunct faculty and consultants
5. Review and steering of the ITRA programme including moderation of activities and allocations
6. Policies regarding participating institutions and research labs
7. Delegation of administrative and financial powers
8. Setting up of ITRA Executive Committee (ITRA EC)

### **ITRA-Advisory Council**

#### **Composition of ITRA-AC:**

1. Dr. R Chidambaram, PSA, GoI (Chairman)
2. Secretary , DIT
3. Sh. N.K. Sinha, Additional Secretary, MHRD
4. Dr. Arabinda Mitra, Head, International Bilateral Cooperation Division, DST
5. Dr. Chandra Shekhar, Director, CEERI Pilani
6. Prof. Bhaskar Ramamurthi, Director, IIT Madras
7. Sh. Ajai Chowdhry, Chairman, HCL Infosystems
8. Sh. Kiran Karnik, Former President, Nasscom
9. Prof. U. B. Desai, Director, IIT Hyderabad
10. Prof. Subhasis Chaudhuri, Dean, IIT Bombay
11. Prof A. K. Majumdar, Indian Institute of Technology, Kharagpur
12. Prof. H. S. Jamadagni, IISc
13. Dr. C. Murali Krishna Kumar, Sr. Advisor (ICT), Planning Commission

14. Prof. Pankaj Jalote, Director, IIT Delhi
15. Prof. Rajeev Sangal, Director, IIT Hyderabad
16. Shri. Abhay Bakre, Joint Development Commissioner, MSME
17. Dr. P Venkat Rangan, Vice Chancellor, Amrita University
18. Prof M.S. Gaur, NIT Jaipur
19. Sh. V. S. Mahalingam, Director, CAIR, DRDO, Bangalore
20. Dr. A.G. Apte, Head, Computer Division, BARC
21. Dr. K. Sethuraman, Engineer-SF, Frequency Management Office, ISRO
22. Dr. G. Venkatesh, CTO, Sasken Communication Technologies
23. MD & CEO, Media Lab Asia
24. Representative of NGO sector (to be decided by Head/DG of ITRA, in consultation with the Chairman)
25. Head/DG ITRA (Member Secretary)

**Terms of Reference (ToR) of ITRA-AC:**

Advisory Council is motivated by the desire to include various sectors of interest to ITRA such as IITs, IIITs, NITs, Private institutions, MHRD, Planning Commission, MSME, DST, CSIR, Strategic Departments (ISRO, DAE, DRDO), MLAsia, industry, industry associations, and NGO's.

**ITRA-Executive Committee**

**Composition of ITRA-EC:**

1. Director, ITRA, Chairman
2. Joint Secretary MHRD, Higher Education, or his Representative
3. Ms. Alpana Dey, HOD (ITRA), DeitY
4. Prof. Sanjiva Prasad, IIT Delhi
5. Prof. Vinod Tare, IIT Kanpur  
Dr. Arbinda Mitra, Advisor, International Bilateral Cooperation Division, DST
6. Ms. Rama Vedashree, Vice President NASSCOM
7. Rep NRI Community
8. Rep MLAsia (to be nominated by MD/CEO MLAsia)
9. Finance Officer-ITRA/MLAsia
10. ITRA Officer

**Terms of Reference (ToR) of ITRA-EC:**

1. Provide guidance to ITRA for effective execution of the programme.
2. Help prepare implementation plans and review the progress of ITRA activities from time to time
3. Optimize distribution of research foci and resources across the ITRA institutions.
4. Help monitor and coordinate the activities of ITRA institutions.
5. Help interface with researchers in India and abroad, particularly to attract them to ITRA.
6. Help establish and maintain connections with industry, government and non-governmental organizations.
7. Help obtain/channel/approve funds for the ITRA institutions/teams from external sponsors.
8. Formulate necessary policies and proposals, and steer them before the competent authorities for necessary approvals.
9. Recommend R&D project proposals for approval, modification or rejection.
10. Any other matters of relevance in the execution of ITRA programme.

## Project Review Steering Group (PRSG)

### Composition of PRSG:

1. Prof. U.B. Desai, Director IIT, Hyderabad, Chairman
2. Mr. B.M. Baveja, GC, R&D in IT Group, DeitY, Co-Chairman
3. Prof. Rajeev Sangal, Director, IIT BHU, Varanasi
4. Prof. Pankaj Jalote (expert- S/w Engg.), Director, IIIT, Delhi
5. Prof. Sanjiva Prasad (expert-IT), HoD, CSE, IIT Delhi
6. Dr. G. Venkatesh (expert-mobile), CTO, Sasken Comm, Chennai
7. Ms. Rama Vedashree, VP, e-gov, NASSCOM, Delhi
8. Dr. Prasun Roy (expert-Health), Sr. Prof., NBRC, DBT
9. Ms. Alpana Dey, Scientist F, HoD, R&D in IT, DeitY

### Terms of Reference of ITRA PRSG:

1. To review Technical and Financial progress of the project.
2. To steer the project from initiation to completion towards achieving specific output leading to useful outcome as per project objectives.
3. To meet and visit the project site as and when required to assess the progress made by the project and to advise the project executing team on new direction/approach and ensure its smooth progress and link-up with the work going on elsewhere in the country for full utilization of the capabilities available in the country.
4. To examine specific request from Chief Investigator, including re-appropriation of funds, enhancement of project outlay, change in the scope of the project, extension of project duration, change in the posts for project personnel, publication of research papers, provision for foreign travel, project completion report, equipment procurement, revision of bar/PERT chart, any other modifications and suggest remedial actions wherever required and make recommendations for consideration by Department of Electronics & Information Technology (DeitY).
5. To advise action regarding completion of the project, establishment of facilities, its utilization and transfer of know how etc.
6. **Roadmap for translation:** PRSG should within 6 months of the commencement of the project, discuss the need and the feasibility of translation/TOT of the proposed output of the project for commercialization. If so feasible, PRSG should hold discussion with experts on the subject from Industry Associations, by inviting them specially to the meetings of the PRSG. PRSG, where possible, shall prepare a roadmap for translation/TOT for commercial production, keeping in view the extant guidelines in the matter.
7. **Cost effectiveness:** PRSG should regularly review & guide the project w.r.t. cost effectiveness of the technologies being developed under the project where relevant. In case the Cost Benefit ratio, where relevant, is likely to be too adverse, PRSG may advise on mid-course correction or pre-closure of the project
8. **Relevance of technology to India:** PRSG should direct the project efforts for development of globally competitive technologies with relevance to the Indian condition & requirements.
9. The Chairman PRSG may co-opt/ invite any other expert for review. TA/DA for the same shall be as per norms applicable to other PRSG members.
10. TA/DA to non-official members will be governed as per norms laid down by Government of India.
11. Term of the PRSG will be till the Project Completion Report submitted by the implementing agency is reviewed by the PRSG and accepted by DeitY and TOT if applicable.

**List of ITRA Personnel**

<b>S.No</b>	<b>Name</b>	<b>Designation</b>	<b>% of time devoted to this project</b>	<b>Date of Joining</b>	<b>Date of Leaving</b>
1	Prof. Narendra Ahuja	Director, ITRA	100%	02/06/2011	-
2	Dr. Umesh Chandra Pandey	Co-ordinator (Technical)-ITRA	100%	04/04/2012	31/03/2013
3	Dr.U.P Phadke	Member, PSIG-ITRA	100%	27/04/2011	04/09/11
4	Dr. Rajeev Shorey	Sr. Level Consultant-ITRA	50%	01/11/2013	31/10/2014
5	Dr. Arun Pande	Sr. Level Consultant-ITRA	50%	01/02/2014	-
6	Dr. P.K. Reddy	Sr. Level Consultant-ITRA	50%	11/11/2013	-
7	Mr. Ram Kishore Gupta	Consultant (Technical)	100%	04/11/2013	03/02/2014
8	Mr.R.G.S Asthana	Consultant	100%	4/6/2012	31/8/2012
9	Mr. Gaurav Sharma	Sr. Research Scientist	100%	22/12/2010	-
10	Mr. Ashok Kumar Katta	Executive Secretary to Director, ITRA	100%	23/09/2013	31/03/2014
11	Ms. Namrata Nagar	Executive Secretary to Director, ITRA	100%	12/05/2014	-
12	Mr. Aakash Sharma	Web Developer	100%	10/10/2013	16/09/2014
13	Mr. Tushar Sharma	Web Developer	100%	25/09/2014	04/12/2014
14	Mr. Sanat Kumar Patra	Management Trainee	100%	05/08/2013	08/01/2015
15	Mr.Lalit Mohan Singh	Assistant – ITRA	100%	01/04/2013	-
16	Ms. Deeksha Gupta	Executive Assistant	100%	08/12/2014	-
17	Ms. Hina Kundaliya	Executive Assistant	100%	15/12/2014	-
18	Ms. Himani Sharan	Executive Assistant	100%	15/12/2014	-

19	Mr. Ajay Thomas Cheruthon	Executive Assistant	100%	07/01/2015	-
20	Mr. Pushpendra Singh Sengar	Executive Assistant	100%	19/01/2015	-
21	Dr. A. Bandyopadhyay	Sr. Consultant	50%	05/01/2015	-
22	Dr. Akshai Runchal	Programme Advisor – ITRA	50%	01/02/2015	-
23	Mr. Roop Kishan Dave	Head, Government Initiatives	100%	10/03/2015	-
24	Prof. Sumit Roy	Sr. Consultant	50%	18/12/2014	

## Performance Based Awards for Students and Teams

ITRA projects are fundamentally team oriented. Teamwork is necessary for many large undertakings in general, and it needs particularly strong attention in the Indian academia and research institutions. The awards below are linked to the performance of the ITRA teams with respect to the fundamental objectives of ITRA.

### 1. GENERAL GUIDELINES

- a. All awards are to be given at the end of a year, based on the performance during the year, applicable to only the following, one year.
- b. The awards will be given to either individual Students or to entire Teams of ITRA Institutions.
- c. The awards are based on self-competition, i.e., making noteworthy leaps in capabilities, and not based on performing better than others. Whether an award is even given in a specific year would depend on whether anyone has made award worthy progress with respect to the award criteria.

### STUDENT AWARDS

#### i. PhD Research Award

**Motivation:** To keep the PhD students inspired and devoted to the research enterprise, and thus help continuously enhance the quality of their research, ITRA plans to periodically recognize their good work.

**Selection:** The yearly research performance of each student would be evaluated and assigned a performance grade at the end of each year, by an evaluation panel comprising mainly of technical experts. The selection criteria are the relevant subset from those given in the Measurement Parameters Table. This grade will be translated into an equivalent Award Percentage (AP). AP received by a student at the end of a given year and any preceding years will be used to determine the award amount to be paid to the student over the following year.

**Award:** The **PhD Research Award** have 2 levels – Exemplary and Outstanding, and are given annually. The number of awards are up to 5 (i.e. 5% of the total PhD students in the Focus Area) at Exemplary level, and up to 25 (i.e. 25% of the total PhD students in the Focus Area) at Outstanding level. Award amounts will be 2 L at Exemplary level and 1 L at Outstanding level.

#### ii. PhD Dissertation Award

**Motivation:** To recognize PhD theses in which the individual contributions made in different parts are of high quality and impact, and have high coherence and integrative value.

**Selection:** The selection of the awardees are done by the evaluation panel, comprising mainly of technical experts.

**Award:** ITRA gives **PhD Dissertation Awards**, in the form of a citation only, without any monetary compensation. PhD theses of the ITRA students are evaluated for quality and impact and those theses meeting a quality threshold will be given the award. A citation along with a gold plated medal are given to each awardee. It is estimated that the number of the award winning theses would be about 5% of the total number of theses considered, i.e., currently an average of about 1 thesis per focus area per year.



## TEAM AWARDS

Faculty leadership is central to the success of the ITRA projects. The team awards are aimed at recognizing the leadership of PIs, Co-PIs and other senior personnel for the collaborative achievements made by their teams.

Each award is in the form of a grant to the team. The recipient team will submit a brief statement of work along with a budget for the award amount. The budget will be flexible in that it could be used for any category of expense, e.g., to attend a different type of conference, invite experts, hire extra students for possible new work, etc., as needed. Any use of the award grant money on large equipment or international travel by the researchers will be acceptable, but it will be subject to the pertinent ITRA policies, and therefore, will require prior ITRA approval.

### i. Team Achievement Awards

**Motivation:** ITRA recognizes overall team performance, in areas related to the ITRA quality metrics, i.e., (i) Research (ii) Curricula Impact (iii) combined Societal Sensitivity Development and Outreach.

**Selection:** Performance of each team over a year is evaluated for its quality with respect to each of the four metrics by a panel comprising mainly of technical experts. The panel will consider the performance of the team with respect to the relevant parameters listed in Measurement Parameters Table and assign grades.

- a. **Award:** ITRA is to give the following *Team Achievement Awards*: (i) **Research Achievement Award**; (ii) **Curricular Impact Award** and (iii) **Combined Societal Sensitivity and Outreach Award**. Up to 1 team per category per focus area may be selected for the award per year. The award will have 2 levels – Exemplary and Outstanding. The award grant amount will be Rs. 10 L (for Outstanding level) or Rs. 20 L (for Exemplary level).

### ii. Partnership Award

**Motivation:** This award category singles out a particularly important aspect of ITRA architecture – Partnering Institutions (PINs) in a pyralet advancing their quality with the help of their Lead Institution (LIN), even though such activities may, in part, also be included among the many comprising outreach, and hence recognized by a part of an ITRA Team awards, e.g., *Societal Sensitivity and Outreach Award*. The extra emphasis on this parameter is due to the critical national need for significantly increasing the number of quality institutions, and the high level of importance ITRA associates with it.

**Selection:** The award is given to a LIN-PIN pair, for their joint work leading to an award worthy enhancement in the PIN's quality, or to an entire pyralet, when all the PINs in a pyralet work closely with the LIN to take advantage of their larger combined scale, and thus derive greater and award worthy enhancement in the quality of all PINs in the pyralet. The award worthiness is judged considering all four quality metrics, using most of the criteria listed in Measurement Parameters Table. While PINs are the intended primary beneficiaries from this joint work, the award will also help LINs to derive well known advantages of mentoring, thus enriching both LINs and PINs. The awardees and the award amounts will be determined by the evaluation panel, comprising mainly of technical experts.

**Award:** The *Partnership Award* will have 2 levels – Exemplary and Outstanding. The number of LIN-PIN pairs to be selected will be up to 1 at Exemplary level, and up to 4 at Outstanding level (i.e. 5% and 15% of institutions in a focus area). The use of this award amount will be planned

jointly by the PIs at the awardee LIN and PIN(s), and directed at further enhancing their partnership activities. Award amounts will be: 6 L at Exemplary level and 3 L at Outstanding level, which amount to 3 L/institution at Exemplary level and 1.5 L/institution at Outstanding level.

iii. **Interdisciplinary Collaboration Award**

**Motivation:** To recognize major cross-fertilization efforts between IT institutions and X (domain specific) institutions in a team, leading to major interdisciplinary advances in IT-in-X research projects.

**Selection:** The awardees and the award amounts will be determined by the evaluation panel, comprising mainly of technical experts.

**Award:** The *Interdisciplinary Collaboration Award* will have 2 levels – Exemplary and Outstanding. The number of awardee pairs will be up to 1 at Exemplary level and up to 4 at Outstanding level (i.e., 5% and 15% of institutions in a focus area). The use of this award amount will be planned jointly by the PIs of the awardee teams, and directed at further enhancing their interdisciplinary activities. Award amounts will be 6 L at Exemplary level and 3 L at Outstanding level, which amount to 3 L/institution for exemplary performance and 1.5 L/institution for Outstanding performance.

iv. **Foresight Award**

**Motivation:** The number of proposals with high innovation content submitted for funding in India is in general quite low. There is a need to encourage potential ITRA teams to be ambitious and come up with bold new ideas as a part of planning for ITRA project activities, particularly for addressing India specific problems. An opportune time for the brainstorming required for coming up with out-of-the-box ideas is when the team is writing the proposals, which they would of course like to see succeed. Accordingly, the ITRA project proposals need to be recognized on the basis of their innovation content.

**Selection:** Evaluation of the ITRA proposals includes identifying relevant, novel, high-risk high-reward ideas. Innovative proposals being sought here are to be distinguished from those proposals containing well thought out, organized plans, but whose impact is expected to be incremental, though useful. Those teams whose proposals are found to be refreshing and innovative beyond a threshold, by a panel of reviewers consisting mostly of technical experts, will be given the award.

**Award:** The *Foresight Award* will be renamed as *Doordarshi Award*, and will be given to a team for submitting a proposal with strategic, innovative, path breaking ideas. Up to 1 team per focus area may be selected for the award. The award grant amount will be Rs. 10 L.

## MEASUREMENT PARAMETERS

<b>1. Research and Development</b>
Publications in Major Peer Reviewed Conferences. Give #, Conf. Tier #, Acceptance Rate. How many with Other Team IIs? How many with more accomplished co-authors (e.g., Mentors/Adjunct Faculty, Others)?
Same for Journals
Other Publications (Books co)authored/edited, Book chapters, Magazine articles, Case studies,...)
Peer Reviewed Conferences in which Project Personnel are Organizers (e.g., as Chairs, Reviewers, Committee Members, ...). Give Tier #.
Peer Reviewed reputed Journals with Acceptance Rates Below 40% in which Project Personnel are involved (e.g., as Reviewers, in editorial duties, ...). Give Tier #, Acceptance Rate.
Interdisciplinary/Multidisciplinary activities (related to any of the rows above)
Invited talks given at major institutions, conferences
# of PhD students involved in the project
# of Masters students
# of Undergrad students
# of Post-Docs
Awards/recognitions by team members
Tools/Technologies developed
Contests Participated in
<b>2. Impact on Curriculum</b>
New Courses/Modules developed
New Labs
Courses/Modules updated in a major way
Labs Updated in a major way
New Textbooks/Topical Monographs authored
Other Institutions inside/outside the team impacted by the above
Interdisciplinary/Multidisciplinary activities (related to any of the rows above)
<b>3. Societal Sensitivity Development</b>
Courses developed and # of Participating Students/Others
Workshops and # of Participating Students/Others
Seminars and # of Participating Students/Others
Discussion Groups and # of Participating Students/Others
Projects/Field Trips and # of Participating Students/Others

Other Institutions in/outside the team impacted by the above
<b>4. Outreach</b>
Summer/Winter Schools and # of Participants
Other Short/Long Courses at Conferences, etc., and # of Participants
Tutorials at Conferences, etc., and # of Participants
Distance Education Courses and # of Participants
Seminars Series and # of Participants
Seminars and # of Participants
Open Houses
Contests Organized
Partner Institutions impacted by the above. Which of the above? In what ways?
Other Institutions impacted by the above. Which of the above? Which Institutions? In what ways?
# of students supported to travel to conference and other events
Major Collaborations with Industry
Major Collaborations with Government
Major Collaborations with NGOs
Major Collaborations with Any Others
Technologies/Solutions/Services/Consultations offered to Industry/Government/NGOs/Others
Industrial/Govt Board Memberships/Licenses/Start-ups

## **Interactions of Teams with Mentors**

Mentors are renowned researchers in an area relevant to the team. They are an integral part of a team proposal and are thus involved from the time of the inception of the team. They are entrusted with and duly credited and rewarded for enhancing the team's performance.

### **A. Modes of Interaction**

1. Visits to teams
2. Hosting visits of team members
3. Remote interaction via video conferencing, etc.

Modes 1 and 2 involve traditional face-to-face interactions. However, remote engagement of the mentors with the teams is highly desirable, particularly for mentors that are located far off. This is because most mentors tend to be renowned researchers with limited time. Given that they hold regular jobs elsewhere, they will be able to spend only a small number of weeks per year visiting the teams. This time will not be adequate for many mentoring activities. For example, discussions on research problems, writing papers, etc. happen over time and cannot be rushed in a short period of intense activity. The required sustained engagement is, however, possible through remote interactions wherein the mentors may contribute smaller chunks of time more frequently. Indeed, this would be a very effective practical way of making speedy progress towards ITRA objectives under the current constraints on faculty availability in India. This is the reason for having Mode 3. It would apply to most of the activities listed in Sec. A, with exceptions being the last two where physical presence of the panel members is required.

THE LIMIT ON THE NUMBER OF INTERNATIONAL MENTORS PER TEAM IS 1. THE NUMBER OF DOMESTIC MENTORS MAY ALSO BE UP TO 1.

All international visits should be discussed with ITRA sufficiently in advance so that ITRA processing is finished and the travel finalized at least one month ahead of the beginning of the travel.

### **B. Mode 1: Mentor Visits to Teams**

1. Mentor visits to the teams are a central and highly encouraged part of ITRA model.
2. All visits should be hosted by the mentor's team. This team may wish to discuss the visit with other teams who may also be interested in the mentor.
3. The host team's PI should discuss an outline of the plans with ITRA at least two months before the visit is to begin and get ITRA's go-ahead before proceeding with the plans.
4. On approval by ITRA, the host team may work out a detailed tentative plan, and ask all other teams if they would like to participate in the activities, organize some by hosting the mentor, etc., and if it suits the mentor, work out a final plan that caters to the needs of all other interested teams. The objective should be to maximize ITRA-wide benefit from the activities.
5. Those activities, of value to other ITRA teams and possibly beyond, e.g., lectures, courses, discussion, etc., may be streamed, e.g., via NKN, other video conference means, etc.

6. The host team PI should inform all other teams, etc., about the plans through direct email, ITRA website, etc.
7. Mentor's role in ITRA team activities is obviously very valuable. The host PI should ensure an efficient and smooth visit, including the interface with any other teams that the mentor may visit. That the activities are useful, efficient and a pleasant experience for all involved, particularly the mentor, is an important duty of the host PI.
8. The organization and execution of a mentor trip are the responsibility of the host team PI.

#### **Guidelines for ITRA's support towards Mentorship Mode 1:**

- i. Each domestic mentor should visit ITRA/teams for a total of at least 3 weeks per year, with no visit of less than 3 days. The honorarium given to them will be Rs. 15K/week. A maximum of 3 visits per year will be supported by ITRA.
- ii. International mentors will visit for at least 3 weeks, over at most 2 trips, with no trip of less than a week. The honorarium paid for a trip will be equivalent of US \$1000 in Indian rupees for the first week's stay in India, and equivalent of US \$250 in Indian Rupees for each subsequent additional week's stay, up to a maximum of 4 weeks' stay in India for execution of the joint project in India. When the international travel of a mentor is not supported by ITRA, s/he will be treated as a domestic mentor.
- iii. Air travel will be as per MLAsia air travel rules [*Annexure 7 of Minutes of the GC Sub-Committee Meeting*].
- iv. Local hospitality including boarding, lodging and local travel will be provided by the host institution.

#### **C. Mode 2: Team Members Visiting Mentors**

Mode 2 activities will be an obvious subset of those under Mode 1 as they will be carried out at the mentor's location. They will provide a greater amount of mentor time, but of course only to those team members visiting the mentor. An added advantage of this mode will be the broader exposure of the visiting member to the different culture of research, etc. prevalent at the mentor's institution.

#### **Guidelines for ITRA's support towards Mentorship Mode 2:**

- I. VISITS OF UP TO 2 STUDENT RESEARCHERS PER INSTITUTION PER YEAR, EACH FOR UP TO 1 SEMESTER (UP TO 135 DAYS), MAY BE SUPPORTED BY ITRA.
- II. VISITING A DOMESTIC MENTOR:
  - a) Living and travel expenses to be given as per team member's parent institution's norms.
  - b) Compensation to Mentor: Since this activity involves engagement of the mentors without going to the mentored institutions, it is comparable to the remote activities under Mode 3. The compensation for Mode 2 is therefore discussed under Mode 3.
- III. VISITING AN INTERNATIONAL MENTOR:

- a) Per diem Allowances, Accommodation charges and Local Transport: \$1750 per month (all inclusive). This will be limited to DA = \$35/day, and Accommodation Charges (on submission of bills) = \$700/mo.
- b) Air travel will be as per MLAsia international air travel rules [Annexure 7 of Minutes of the GC Sub-Committee Meeting]
- c) Host Institution Costs = \$1000
- d) Compensation to Mentor: Since this activity involves engagement of the mentors without going to the mentored institutions, it is comparable to the remote activities under Mode 3. The compensation for Mode 2 is therefore discussed under Mode 3.
- e) Other Expenses (Travel Insurance, medical etc..) = up to Rs. 15,000

#### **D. Mode 3: Mentors Interacting Remotely**

Effective remote interaction can be had for most of the activities listed in Sec. A, except for the last two where physical presence of the panel members is required.

THE OVERALL DESIGN OF THE PROPOSED MECHANISM FOR ASSESSING THE TIME SPENT BY THE MENTORS REMOTELY, AND FOR COMPENSATING MENTORS FOR THIS TIME, IS GIVEN IN THE TABLE “COMPUTATION OF THE HOURS SPENT BY A MENTOR IN INTERACTION MODES 2 AND 3” [ANNEXURE 9 OF MINUTES OF THE GC SUB-COMMITTEE MEETING]. THE DESIGN SHOULD BE CAREFULLY REFINED BY INCORPORATING THE EXPERIENCE GAINED IN THE EARLY STAGES OF IMPLEMENTATION. ITRA MAY PAY AN HONORARIUM TO THE MENTORS FOR MODE 2 AND MODE 3 ACTIVITIES AS DESCRIBED IN THE GUIDELINES BELOW.

#### **Guidelines for ITRA’s support towards Mentorship Mode 3:**

- i. **Domestic Mentors:** Based upon time spent on activities involving visiting student researcher(s), as estimated using applicable parts of the method given in *Annexure 9 of Minutes of the GC Sub-Committee Meeting*. The compensation will be Rs. 15K/week, subject to the constraint that the total compensation to a mentor for Modes 1, 2 and 3 activities does not exceed Rs. 1.2 L/year.
- ii. **International Mentors:** Based upon time spent on activities involving visiting student researcher(s), as estimated using the applicable parts of the method given in *Annexure 9 of Minutes of the GC Sub-Committee Meeting*. The compensation will be equivalent of US \$1000/week in Indian rupees, subject to the constraint that the total compensation to a mentor for Modes 1, 2 and 3 activities does not exceed US \$7,500/year.

### List of Mentors for ITRA-Water and ITRA-Mobile projects

S.No.	Name & Affiliation	ITRA-Institution/Team associated with	Focus Area
1	Prof. Praveen Kumar, Univ. of Illinois at Urbana Champaign, IL, USA	<ol style="list-style-type: none"> <li>1. Indian Institute of Technology Bombay</li> <li>2. Indian Institute of Technology, Hyderabad</li> <li>3. Govt. College of Engineering, Amravati</li> <li>4. Shri Shivaji College of Horticulture, Amravati</li> </ol>	ITRA-Water
2	Dr. Dev Niyogi, Purdue Univ., Indiana, IN, USA	<ol style="list-style-type: none"> <li>1. Indian Institute of Technology Bombay</li> <li>2. Indian Institute of Technology, Hyderabad</li> <li>3. Govt. College of Engineering, Amravati</li> <li>4. Shri Shivaji College of Horticulture, Amravati</li> <li>5. Indian Institute of Science, Bangalore</li> <li>6. BITS Pilani, Hyderabad</li> <li>7. NIT Warangal</li> </ol>	ITRA-Water
3	Prof. Binayak P. Mohanty, Texas A&M Univ., College Station, TX, USA	<ol style="list-style-type: none"> <li>1. Indian Institute of Technology, Bhubaneswar</li> <li>2. Indian Institute of Technology, Kharagpur</li> <li>3. Kalinga Institute of Industrial Technology, Bhubaneswar</li> <li>4. Indian Institute of Science, Bangalore</li> <li>5. Centre for Development of Advanced Computing (CDAC), Thiruvananthapuram</li> <li>6. BITS Pilani, Hyderabad</li> <li>7. NIT Warangal</li> </ol>	ITRA-Water
4	Prof. V. Sridhar, Virginia Tech, Roanoke, VA, USA	<ol style="list-style-type: none"> <li>1. Institute of Technology Kharagpur</li> <li>2. IIT Gandhinagar</li> <li>3. IGKV Raipur</li> </ol>	ITRA-Water
5	Prof. Adit Singh, Auburn Univ., Auburn, AL, USA	<ol style="list-style-type: none"> <li>1. University of Hyderabad</li> <li>2. VNRVJIET Hyderabad</li> <li>3. SUIIT Orissa</li> <li>4. IIIT, Hyderabad</li> <li>5. SCCE Karimnagar</li> <li>6. SCIT Karimnagar</li> </ol>	ITRA-Water
6	Prof. James Phillip King, New Mexico State Univ., Las Cruces, USA	<ol style="list-style-type: none"> <li>1. Indian Institute of Technology Bombay</li> <li>2. Indian Institute of Technology, Hyderabad</li> <li>3. Govt. College of Engineering, Amravati</li> <li>4. Shri Shivaji College of Horticulture, Amravati</li> </ol>	ITRA-Water
7	Prof. Sajal K Das, Univ. of Texas, Arlington, USA	<ol style="list-style-type: none"> <li>1. I.I.T. Kharagpur</li> <li>2. I.I.M. Calcutta</li> <li>3. Bengal Engg and Science University</li> <li>4. N.I.T. Durgapur</li> <li>5. Heritage Institute of Technology , Kolkata</li> <li>6. Kalyani Govt Engineering College, Kalyani</li> <li>7. Jadavpur University</li> <li>8. University of Calcutta</li> <li>9. Bengal Engineering and Science University</li> </ol>	ITRA-Mobile



		<ul style="list-style-type: none"> <li>10. Kalinga Institute of Industrial Technology University, Bhubaneswar</li> <li>11. National Institute of Technology, Durgapur</li> <li>12. Feroze Gandhi Institute of Engineering and Technology, Raebareli</li> <li>13. Amrita Vishwa Vidyapeetham, Kerela</li> <li>14. Indian Institute of Space Science &amp; Technology, Trivandrum</li> <li>15. Indian Institute of Information Technology and Management, Kerala</li> </ul>	
8	Prof. Frank P. Kelly , Statistical Lab, Cambridge, UK	<ul style="list-style-type: none"> <li>1. Indian Institute of Technology, Madras</li> <li>2. The Institute of Mathematical Sciences, Chennai</li> <li>3. Indian Institute of Management, Bangalore</li> </ul>	ITRA-Mobile
9	Prof. Kaliappa Ravindran, City Univ. of New York, New York, NY, USA	<ul style="list-style-type: none"> <li>1. Indian Institute of Technology Delhi</li> <li>2. LN Mittal Institute of Information Technology, Jaipur</li> <li>3. NIIT University, Neemrana</li> <li>4. Institute of Radio physics and Electronics, Calcutta University, Kolkata</li> </ul>	ITRA-Mobile
10	Prof. Sukumar Ghosh, Univ. of Iowa, Iowa City, IA, USA	<ul style="list-style-type: none"> <li>1. I.I.T. Kharagpur</li> <li>2. I.I.M. Calcutta</li> <li>3. Bengal Engg and Science University</li> <li>4. N.I.T. Durgapur</li> <li>5. Heritage Institute of Technology , Kolkata</li> <li>6. Kalyani Govt Engineering College, Kalyani</li> <li>7. Jadavpur University</li> <li>8. University of Calcutta</li> <li>9. Bengal Engineering and Science University</li> <li>10. Kalinga Institute of Industrial Technology University, Bhubaneswar</li> <li>11. National Institute of Technology, Durgapur</li> <li>12. Feroze Gandhi Institute of Engineering and Technology, Raebareli</li> </ul>	ITRA-Mobile
11	Prof. K. K. Ramakrishnan, Univ. of California, Riverside, CA, USA	<ul style="list-style-type: none"> <li>1. Indian Institute of Technology, Bombay</li> <li>2. PEC University of Technology, Chandigarh</li> </ul>	ITRA-Mobile
12	Prof. Supratik Mukhopadhyay, Louisiana State Univ., Baton Rouge, LA, USA	<ul style="list-style-type: none"> <li>1. Jadavpur University</li> <li>2. University of Calcutta</li> <li>3. Bengal Engineering and Science University</li> <li>4. Kalinga Institute of Industrial Technology University, Bhubaneswar</li> <li>5. National Institute of Technology, Durgapur</li> <li>6. Feroze Gandhi Institute of Engineering and Technology, Raebareli</li> </ul>	ITRA-Mobile

13	Prof. Prashant Pillai, Univ. of Bradford, Bradford, UK	<ol style="list-style-type: none"> <li>1. I.I.T. Kharagpur</li> <li>2. I.I.M. Calcutta</li> <li>3. Bengal Engg and Science University</li> <li>4. N.I.T. Durgapur</li> <li>5. Heritage Institute of Technology , Kolkata</li> <li>6. Kalyani Govt Engineering College, Kalyani</li> </ol>	ITRA-Mobile
14	Prof. Archan Misra, Singapore Management Univ., Singapore	<ol style="list-style-type: none"> <li>1. I.I.T. Kharagpur</li> <li>2. I.I.M. Calcutta</li> <li>3. Bengal Engg and Science University</li> <li>4. N.I.T. Durgapur</li> <li>5. Heritage Institute of Technology , Kolkata</li> <li>6. Kalyani Govt Engineering College, Kalyani</li> <li>7. IIIT Hyderabad</li> <li>8. BVRIT, Hyderabad</li> <li>9. VNRVJIET Hyderabad</li> </ol>	ITRA-Mobile
15	Dr. Giridhar Mandyam, Nokia Research Center, San Diego, CA, USA	<ol style="list-style-type: none"> <li>1. IIT, Bombay</li> <li>2. IIT Madras</li> <li>3. TIFR Mumbai</li> <li>4. NIT Durgapur</li> <li>5. NIT Suratkhal</li> <li>6. PEC University of Technology, Chandigarh</li> </ol>	ITRA-Mobile
16	Prof. Nitin Vaidya, Univ. of Illinois, Urbana, IL, USA	<ol style="list-style-type: none"> <li>1. Indraprastha Institute of Information Technology, Delhi</li> <li>2. Shiv Nadar University, Noida</li> <li>3. Indira Gandhi Delhi Technological University of Women, Delhi</li> <li>4. Amrita Vishwa Vidyapeetham, Kerela</li> <li>5. Indian Institute of Space Science &amp; Technology, Trivandrum</li> <li>6. Indian Institute of Information Technology and Management, Kerala</li> <li>7. Indian Institute of Technology Delhi</li> <li>8. LN Mittal Institute of Information Technology, Jaipur</li> <li>9. NIIT University, Neemrana</li> <li>10. Institute of Radio physics and Electronics, Calcutta University, Kolkata</li> </ol>	ITRA-Mobile
17	Prof. Sumit Roy, Univ. of Washington, Seattle, USA	<ol style="list-style-type: none"> <li>1. Indraprastha Institute of Information Technology, Delhi</li> <li>2. Shiv Nadar University, Noida</li> <li>3. Indira Gandhi Delhi Technological University of Women, Delhi</li> </ol>	ITRA-Mobile

## **Interactions of Teams with Adjunct Faculty**

Adjunct Faculty (AF) are renowned researchers in an area relevant to the team. They may perform most of the functions normally performed by a mentor, but the mentors are an integral part of a team proposal, usually involved from the time of the inception of the team. AF are entrusted with and duly credited and rewarded for enhancing the team's performance. AF may also be invited to complement the mentors from time to time. AF may choose to become mentors if need arises as they work with the teams.

An AF coming from an academic institution will be compared with and classified by ITRA Executive Committee into one of three categories of equivalent IIT faculty: Assistant Professor, Associate Professor, and Professor. An AF coming from a non-academic institution will also be mapped onto one of the same categories by ITRA Executive Committee.

Unlike mentors, Adjunct Faculty (AF) will not be involved regularly and integrally in the projects. However, when engaged, the impact of AF on the teams will be comparable to that of the mentors. Typically, involvement of AF will be triggered by their chance availability, for longer periods such as during sabbatical or other leaves. The proposed modes of interaction include visits to teams and sometimes remote interactions. The maximum number of AFs supported by ITRA, as provisioned in ITRA EFC, is 51.

### **A. Modes of Interaction**

1. Visits to teams
2. Remote interaction via video conferencing, etc.

### **B. Adjunct Faculty Visits to Teams**

1. AF visits to the teams are encouraged.
2. Any team may host an AF. This team may also wish to discuss the visit with other teams who may also be interested in the AF.
3. The host team's PI should discuss an outline of the plans with ITRA at least two months before the visit is to begin and get ITRA's go-ahead before proceeding with the plans.
4. On approval by ITRA, the host team may work out a detailed tentative plan, and ask all other teams if they would like to participate in the activities, organize some by hosting the AF, etc., and if it suits the AF, work out a final plan that caters to the needs of all other interested teams. The objective should be to maximize ITRA-wide benefit from the activities.
5. Those activities, of value to other ITRA teams and possibly beyond, e.g., lectures, courses, discussion, etc., may be streamed to all interested, e.g., via NKN, other video conference means, etc.
6. The host team PI should inform all other teams and any others about the plans through direct email, ITRA website, etc.
7. The host PI should ensure an efficient and smooth visit, including the interface with any other teams that AF may visit. That the activities are useful, efficient and a pleasant experience for all involved, particularly the AF, is an important duty of the host PI.
8. The organization and execution of an AF trip are the responsibility of the host team PI.

### **C. Guidelines for ITRA's support towards an Adjunct Faculty for Visiting Teams**

1. When visiting an institution engaged in an ITRA project, an AF will be typically engaged not only in ITRA project activities but also in other institutional activities, such as teaching, course/lab development, etc. Since most institutions in India are in serious need of quality faculty, and may be expected to happily avail of the opportunity of having a quality researcher as visiting faculty, ITRA will act only as a facilitator of these opportunities; the host institution will need to compensate the AF for salary, local hospitality including boarding, lodging and local travel.
2. Towards the interaction of the AF with an ITRA team at a host team institution, ITRA will support travel of the AF if the visit is for at least a month. For shorter visits, the travel will also have to be supported by the host institution.
3. Travel of an international AF will be supported by ITRA as per MLAsia international air travel rules [*Annexure 7 of Minutes of the GC Sub-Committee Meeting*]. The total cost will be limited to Rs. 1 L, for round trip economy air fare by shortest route between AF's place of stay/work and the place of host institution.
4. Travel support for a domestic AF will be limited to Rs. 25,000, for round trip economy air fare by shortest route between AF's place of stay/work and the place of host institution will be provided by ITRA.
5. All international visit plans should be finalized by the host team PI working with ITRA at least one month before the beginning of the travel.

## **International Travel of Researchers**

The principal objective of ITRA is to catapult the quality and quantity of advanced IT Research in India. Integral to this objective is further strengthening the sense of research quality and understanding of research methodology in the ITRA faculty, students and other team members, and building local and global collaborative relationships, including through interactions with mentors and other renowned experts in their domains.

One important way in which this can be realized is by helping Indian researchers present their work at international fora. In addition to the fact that most conferences accept papers under the condition that the each paper is actually presented by an author at the conference site, being at such conferences provides a valuable opportunity for face to face interactions and building relationships with professional colleagues. It is a standard method for the new researchers to connect and succeed. It may lead to closer collaborations and fruitful new research partnerships.

Since many of the major conferences are often held outside India, there is a need for supporting international travel by researchers. ITRA considers attending at least 2 good quality conferences annually to be essential for any research group to enhance the quality metrics by which their performance is to be evaluated. ITRA team members shall therefore be supported to present research papers at international conferences or workshops; etc. that have already been identified or accepted by ITRA as quality venues.

The decision for supporting travel to present papers at conferences shall be made using predetermined criteria by a committee duly constituted by ITRA. The general guidelines for the committee shall include the following:

1. The total number of visit slots for ITRA researchers per year per focus area will be 50.
2. Support to only one author per paper will be provided by ITRA.
3. All international visits should be discussed and finalized with ITRA at least one month before the beginning of the travel.
4. The paper must have been submitted at least 3 months after the beginning of project, and no later than 3 months after the end of the project.
5. The quality of the paper, the reputation of the conference, frequency of recent travel supported by ITRA, the standing of the author's institution will be considered, along with whether the paper and the conference represent good research achievement and/or adequate improvement by the author over an appropriate period just preceding the current conference. ITRA will form a list of reputable conferences for each focus area.
6. Students need to be particularly encouraged, e.g., to present their research findings at conferences, so they get exposed to the latest developments in their field of interest and develop confidence that they can also publish and lead the way like others who they may otherwise have only heard of or read about. The faculty should also be supported to participate in international conferences. Following is the high to low priority order for providing travel support to the eligible ITRA researchers: PIN student researchers, PIN faculty researchers, LIN student researchers, and LIN faculty researchers. Also, first time authors may be given extra encouragement. Specifically, the available international travel support will be distributed among students, PIN faculty and LIN faculty in the proportion 5, 3 and 2. Exceptions will be possible if there are not enough candidates to maintain the proportions.

7. Each conference visit slot will be for up to 5 days, excluding travel days.
8. A common structure of ITRA support to faculty as well as students for attending the conference shall be provided, and this support shall be for costs under the following common heads: Air Travel, Visa, Hotel accommodation, DA, Taxi, Registration and Travel Insurance. Reimbursement will be made on production of actual bills. [Annexure 10 of Minutes of the GC Sub-Committee Meeting]
9. Whenever travel to an international mentor or adjunct faculty is otherwise planned in the general time frame of the international conference, merging of the two may be explored to economize on the total cost.

**List of projects in ITRA-Mobile**

**Start date of Project:** Jan 1, 2014

**Duration:** 3 Years

<b>Transportation Cluster</b>
<p><b>Title:</b> HumanSense: Towards context aware sensing, inference and actuation for applications in Energy and Healthcare.</p> <p><b>Team:</b></p> <ul style="list-style-type: none"><li>(i) Indraprastha Institute of Information Technology, Delhi (IIITD) – Lead Institution</li><li>(ii) Shiv Nadar University, Gautam Budh Nagar (SNU)</li><li>(iii) Indira Gandhi Delhi Technical University For Women, Delhi (IGDTUW)</li></ul> <p><b>PI:</b> Dr. Amarjeet Singh; IIIT, Delhi</p> <p><b>Objectives:</b> To develop systems combining relevant sensors and diverse mobile platforms for collecting useful domain specific information and correspondingly develop algorithms for efficient inference and decision making based on collected real world data.</p> <p><b>Outlay Rs.:</b> 198.59 lakhs</p>
<p><b>Title:</b> De-congesting India's transportation networks using mobile devices</p> <p><b>Team:</b></p> <ul style="list-style-type: none"><li>(i) Indian Institute of Technology, Madras (IITM) - Lead Institution</li><li>(ii) Institute of Mathematical Sciences, Chennai (IMSc)</li><li>(iii) Indian Institute of Management, Bangalore (IIMB)</li></ul> <p><b>PI:</b> Dr Krishna Jagannathan, IIT Madras</p> <p><b>Objectives:</b> The proposal envisages the use of mobile phones to estimate congestion and traffic patterns on urban roads. Based on the congestion metrics obtained, the proposal aims to develop algorithms and tools for traffic planning and management, using the mobile phone as a service platform.</p> <p><b>Outlay Rs.:</b> 193.27 lakhs</p>
<p><b>Title:</b> CARTS: Communication Assisted Road Transportation Systems</p> <p><b>Team:</b></p> <ul style="list-style-type: none"><li>(i) Indian Institute of Technology, Bombay (IITB) - Lead Institution</li><li>(ii) PEC University of Technology, Chandigarh (PEC)</li></ul> <p><b>PI:</b> Dr Bhaskaran Raman, IIT Bombay</p>

Objectives: To create an overarching communication framework that can help ease congestion, while also making it much easier for consumers to use public transportation systems. This framework will alleviate road traffic issues using information gathered from and disseminated via mobile phones.

Outlay Rs.: 75.90

### Healthcare Cluster

Title: Remote Health: A Framework for Healthcare Services using Mobile and Sensor-Cloud Technologies

Team:

- (i) Jadavpur University, Kolkata (JU) – Lead Institution
- (ii) University of Calcutta, Kolkata (UoC)
- (iii) Bengal Engineering and Science University, Shibpur (BESU)
- (iv) Kalinga Institute of Industrial Technology, Bhubaneswar (KIIT)
- (v) Feroze Gandhi Institute of Engineering and Technology, RaeBareli (FGIET)
- (vi) National Institute of Technology, Durgapur (NITD)

PI: Prof Nandini Mukherjee, Jadavpur University

Objectives: (i) To find efficient solutions to pervasive healthcare services over wireless networks while ensuring the quality of service requirements. (ii) To find suitable mechanism for representation of healthcare data using semi-structured data model and integration of such data model with sensor-cloud towards building a cloud-based Electronic Health Record System. (iii) To develop service integration (like video-medic) techniques and knowledge extraction techniques for mobile healthcare applications

Outlay Rs.: 433.98 lakhs

Title: Virtual Assistant for Mobile Devices using Voice and Gesture Technologies

Team:

- (i) International Institute of Information Technology, Hyderabad (IIITH) -Lead Institution
- (ii) VNR Vignana Jyothi Institute of Engineering & Technology, Hyderabad (VNRVJIET)
- (iii) Padmashri Dr. B. V. Raju Institute of Technology, Vishnupur(BVRIT)

PI: Dr. Kishore Prahallad, IIIT Hyderabad

Objectives: Current interfaces on a mobile phone are based on alpha-numeric keys and touch technologies, which expect a human being to operate over a tiny area. These interfaces are extremely sub-optimal and restricted for literate/illiterate and differently-abled. Our proposal aims to overcome this limitation of and build a rich interface using voice and gesture based technologies for a multi-modal mobile interaction and computing.

Outlay Rs.: 134.29 lakhs

Title: Uncoordinated, secure and energy aware access in distributed wireless networks

Team:

- (i) Indian Institute of Technology (IITB), Bombay - Lead Institution



- (ii) Tata Institute of Fundamental Research (TIFR), Bombay
- (iii) National Institute of Technology (NITK), Surathkal, Karnataka
- (iv) National Institute of Technology (NITD), Durgapur

PI: Prof. Bikash Kumar Dey, IIT Bombay

Objectives: This project proposal envisages the design of communication strategies in uncoordinated network settings, e.g. military networks/vehicular networks with the following three main features. (i) Efficient multi-user distributed strategies for maximizing the data-rates under communication constraints on power/bandwidth/delay, while coordinating the participating users with limited information exchange; (ii) Enhanced secure data access in distributed wireless systems where information dissemination to unwanted entities should be guarded against. (iii) Protocols and fundamental limits of data rate transmission in uncoordinated networks with renewable energy sources, e.g. solar/wind energy.

Outlay Rs.: 182.52 lakhs

### **Disaster Management Cluster**

Title: Post-Disaster Situation Analysis and Resource Management Using Delay-Tolerant Peer-to-Peer Wireless Networks (DISARM)

Team:

- (i) Indian Institute of Technology, Kharagpur (IITKGP) – Lead Institution
- (ii) Indian Institute of Management, Kolkata (IIMC)
- (iii) Bengal Engineering and Science University, Shibpur (BESU)
- (iv) National Institute of Technology, Durgapur (NITD)
- (v) Kalyani Government Engineering College, Kalyani (KGEC)
- (vi) Heritage Institute of Technology, Kolkata (HIT)

PI: Prof. Niloy Ganguly, IIT Kharagpur

Objectives: To develop (i) A wireless communication infrastructure using the disruption –prone network with the help of smart phone and allied rapidly deployable device based peer-to-peer Delay Tolerant Network; (ii) A robust Framework that will lead to a global need assessment from the piecewise localized views of the rescue teams and victims; and, (iii) A coordination system to guide the resource distribution process to provide core disaster management services to the victims.

Outlay Rs.: 316.23 lakhs

Title: Mobile Broadband Service Support over Cognitive Radio Networks

Team:

- (i) Indian Institute of Technology Delhi, New Delhi (IITD) - Lead Institution
- (ii) NIIT University, Neemrana (NIITU)
- (iii) LN Mittal Institute of Information Technology, Jaipur (LNMIIT)
- (iv) Institute of Radiophysics and Electronics, Calcutta University, Kolkata (IRPECU)

PI: Dr. Shankar Prakriya, IIT Delhi

Objectives: This project aims to study and investigate (i) Limits of communication, performance analysis – distributed systems characteristic of healthcare; (ii) Spectrum Sensing – tradeoffs for QoS; (iii) Interference management – EMI to healthcare equipment; (iv) Cross-layer optimization & scheduling issues; (v) Hardware platform development; and, (vi) Location and security issues.

Outlay Rs.: 426.28 lakhs

Title: Micronet - Mobile Infrastructure for Coastal Region Offshore Communications & Networks

Team:

- (i) Amrita Vishwa Vidyapeetham, Coimbatore (AVV) - Lead Institution
- (ii) Indian Institute Of Space Science and Technology, Thiruvananthapuram (IIST)
- (iii) Indian Institute of Information Technology and Management-Kerala, Thiruvananthapuram (IIITM-K)

PI: Dr. Maneesha Ramesh, Amrita Vishwa Vidyapeetham, Kerala

Objectives: Project's primary objectives are to provide a Mobile Infrastructure for coastal regions of India to enable Offshore Communications and to solve the technology challenges faced by the fishermen community in India today, specifically in providing communications and connectivity while they are out at sea. The validation goal is to realize low cost hybrid terrestrial and marine based environment solution in a "phased manner".

Outlay: Rs. 175.25 lakhs

**Summary of the quantitative measures of the progress achieved by nine mobile teams.**

Area	Year 1
<b>1. Research and Development</b>	
# of Publications in Peer Reviewed Conferences included in the ITRA List or of the same Caliber	63
# of Publications in Major Peer Reviewed Journals included in the ITRA List or of the same Caliber	16
# of Peer Reviewed Conferences in which Project Personnel are Organizers (e.g., as Chairs, Reviewers, Committee Members, ...)	69
# of Peer Reviewed Journals included in the ITRA List or of the same Calibre in which Project Personnel are involved (e.g., as Reviewers, in editorial duties, )	38
# of invited talks given at major institutions, conferences	30
# of PhD students in the project	76
# of Masters students	39
# of Undergrad students	41

# of students supported to travel to conferences	11
# of Post-Docs	0
# of Tools/Technologies developed	2
# of Technical contests held for solving various technical/other field-relevant challenges organized by professional societies and other organizations from time to time	2
<b>2. Impact on Curriculum</b>	
# of New Courses/Modules developed	10
# of New Labs	7
# of Courses/Modules updated in a major way	4
# of Labs Updated in a major way	4
# of New Textbooks authored	4
# of Other Institutions inside/outside the team impacted by the above	6
<b>3. Combined Outreach and Societal Sensitivity Development</b>	
# of Summer/Winter Schools and # of Participants	12(800)
# of other Short/Long Courses at Conferences, etc., and # of Participants	4(300)
# of Tutorials at Conferences, etc., and # of Participants	3
# of Distance Education Courses and # of Participants	1
# of Seminars Series and # of Participants	3(50)
# of Seminars and # of Participants	3
# of Open houses where the work being done by the team is exhibited to colleges, schools, public at large, etc., to increase their understanding and appreciation of research in science and engineering	40
# of Contests held for solving various outreach and societal sensitivity challenges organized by NGO and other organizations from time to time	0
# of Other Institutions in/outside the team impacted by the above	0
# of Major Collaborations with Industry. Describe such collaborations and progress made	0
# of Major Collaborations with Government. Describe such collaborations and progress made	9

# of Major Collaborations with NGOs. Describe such collaborations and progress made.	2
# of Major Collaborations with Any Others. Describe such collaborations and progress made	0
# of Technologies/Solutions/Services/Consultations offered to Industry/Government/NGOs/Others	1
# of Industrial Board Memberships/Licenses/Start-ups	1

**List of projects in ITRA-Water**

**Start date of Project:** Jan 1, 2014

**Duration:** 3 Years

<b>Improving groundwater levels and quality through enhanced water use efficiency in agriculture</b>
<p><b>Title:</b> ICT in Water and Pest/Disease Management for Yield Improvement in Horticulture (Citrus)</p> <p><b>Team:</b></p> <ul style="list-style-type: none"><li>(i) Indian Institute of Technology Bombay, Mumbai (IITB) - Lead Institute</li><li>(ii) Indian Institute of Technology, Hyderabad (IITH)</li><li>(iii) Govt. College of Engineering, Amravati (GCEA)</li><li>(iv) Shri Shivaji College of Horticulture, Amravati (SSCHA)</li></ul> <p><b>PI:</b> Prof. J. Adinarayana, IIT Bombay</p> <p><b>Objectives:</b> Utility of Information Communication and Dissemination Technologies in agriculture for (i) Groundwater trends and quality improvement for enhanced water use efficiency (ii) Automated drip irrigation and water management. (iii) Crop water, pest / disease monitoring and modeling services for yield improvement. (iii) Integrated model and interoperable services.</p> <p><b>Outlay: Rs. 214.47 lakhs</b></p>
<p><b>Title:</b> Improving Groundwater Levels and Quality through Enhanced Water Use Efficiency in Eastern Indian Agriculture</p> <p><b>Team:</b></p> <ul style="list-style-type: none"><li>(i) Indian Institute Of Technology, Bhubaneswar (IITBBSR) - Lead Institution</li><li>(ii) Indian Institute Of Technology, Khargpur (IITKGP)</li><li>(iii) Kalinga Institute of Industrial Technology University, Bhubaneswar (KIITU)</li></ul> <p><b>PI:</b> Prof. R. K. Panda, IIT BBSR</p> <p><b>Objectives:</b> (i) Development of a few representative Digital Catchments in eastern India for better understanding of their spatio-temporal dynamics and water balance across various hydrologic reservoirs and their underlying cause/effect relationships at different scales. (ii) Monitoring aquifer recharge and recovery pertaining to present agricultural and other activities at different spatial (field, catchment) and temporal (monthly, seasonal, annual) scales using wireless technology. (iii) Evaluation of different storm-water management, innovative agricultural water management, conjunctive use of surface and ground water, and aquifer recharge techniques for reversing the declining trend of groundwater table in the study aquifers. (iv) Study of the effect of climate variability on water resources availability in general and soil moisture availability in the root zone in particular for the eastern India through pilot experiments, historical data analysis, and simulation modeling. (v) Formulation of regional up- and downscaling relationships for root zone soil moisture and groundwater recharge attributes using field experiments and</p>

available ISRO and NASA satellite remote sensing data. (vi) Development of a Decision Support System (DSS) for determination of best management practices (BMP) for all scenarios of water resources management for the study catchments and groundwater aquifers and extrapolation of the findings to other basins.

**Outlay Rs.: 223.31 lakhs**

**Title:** Measurement to Management (M2M): Improved Water Use Efficiency and Agricultural Productivity through Experimental Sensor Network

**Team:**

- (i) Indian Institute of Technology, Kharagpur (IITKGP) - Lead Institute
- (ii) Indian Institute of Technology, Gandhinagar (IITGN)
- (iii) Indira Gandhi Krishi Vishwavidyalaya, Raipur (IGKV)

**PI:** Prof. N. S. Raghuwanshi; IIT Kharagpur

**Objectives:** (i) To develop an experimental sensor network for monitoring of climate, soil (nutrient and fertilizer), and water conditions during the crop growing seasons at field scales; (ii) To develop a regional crop monitoring system using the historic and near real-time remotely sensed vegetation index datasets that can monitor crop growth on a weekly basis; (iii) To develop a hydrologic modeling framework at watershed and regional scales that can provide estimates of weekly soil moisture (drought maps), evapotranspiration, runoff, and groundwater levels; (iv) To use information from experimental sensor network, remote sensing monitoring and sophisticated hydrologic models to develop and test an irrigation scheduling and water management system; (v) To evaluate the sensitivity of crop yield towards varying soil, water, and climate conditions taking information of key variables from the field and regional scale monitoring systems that can provide an assessment of potential changes in crop yields and water availability under climatic change conditions.

**Outlay: Rs. 320.95 lakhs**

### **Total urban water management to achieve 24/7 availability**

**Title:** Integrated Urban Flood Management in India: Technology-Driven Solutions

**Team:**

- (i) Indian Institute of Science, Bangalore (IISc) - Lead Institution
- (ii) Centre for Development of Advanced Computing, Trivandrum (CDACT)
- (iii) Birla Institute of Technology and Science Pilani –Hyderabad Campus, Hyderabad (BITSH)
- (iv) National Institute of Technology, Warangal (NITW)

**PI:** Prof. P.P. Mujumdar, IISc Bangalore

**Objectives:** (i) To develop real-time flood forecasting models for urban areas in the country, assimilating data and information from satellite products, Doppler weather radars, automatic weather stations and state-of-the-art numerical weather prediction and hydrologic models. (ii) To develop operational models for real-time management of urban drainage systems using water level sensors and control systems algorithms integrated with GIS. (iii) To develop models and methodologies for communicating the forecasts to different levels of decision making mechanisms. (iv) To project the likely changes in the

frequencies of high intensity rainfall using extreme value theory and stochastic weather generators and to examine the adequacy of capacity of the existing structural measures to cope with the changing climate. (v) To demonstrate the application of the models and the end- to –end implementation integrating the models – sensors – decision framework through a pilot project. (vi)To lead the development of post-flood management training and educational material.

**Outlay Rs. 292.81 lakhs**

**Title:** Development of effective Wireless Sensor Network system for water quality and quantity monitoring (AquaSense)

**Team:**

- (i) University of Hyderabad, Hyderabad (UOH) - Lead Institute;
- (ii) Vallurupalli Nageswara Rao Vignana Jyothi Institute of Engineering and Technology (VNRVJIET), Hyderabad;
- (iii) Sambalpur University Institute of Information Technology (SUIIT), Sambalpur, Orissa;
- (iv) International Institute of Information Technology (IIITH), Hyderabad;
- (v) Sree Chaitanya College of Engineering (SCCE), Karimnagar, AP;
- (vi) Sree Chaitanya Institute of Technological Sciences (SCIT), Karimnagar, AP;

**PI:** Prof. Siba K Udgata; Univ. of Hyderabad

**Objectives:** To develop an indigenous, intelligent and adaptive decision support system for on-line remote monitoring of the water flow and water quality across the wireless sensor zone to generate data pertaining to utilization of water and raising alerts in terms of mails/messages/alarm following any violation in the safety norms for the drinking water quality and usage of amount of water.

**Outlay Rs.: 290.92 lakhs**

**Summary of the quantitative measures of the progress achieved by five water teams.**

Area	Year 1
<b>2. Research and Development</b>	
# of Publications in Peer Reviewed Conferences included in the ITRA List or of the same Caliber	22
# of Publications in Major Peer Reviewed Journals included in the ITRA List or of the same Caliber	18
# of Peer Reviewed Conferences in which Project Personnel are Organizers (e.g., as Chairs, Reviewers, Committee Members, ...)	27

# of Peer Reviewed Journals included in the ITRA List or of the same Calibre in which Project Personnel are involved (e.g., as Reviewers, in editorial duties, )	33
# of invited talks given at major institutions, conferences	34
# of PhD students in the project	27
# of Masters students	26
# of Undergrad students	22
# of students supported to travel to conferences	4
# of Post-Docs	1
# of Tools/Technologies developed	6
# of Technical contests held for solving various technical/other field-relevant challenges organized by professional societies and other organizations from time to time	4
<b>2. Impact on Curriculum</b>	
# of New Courses/Modules developed	10
# of New Labs	7
# of Courses/Modules updated in a major way	4
# of Labs Updated in a major way	6
# of New Textbooks authored	2
# of Other Institutions inside/outside the team impacted by the above	3
<b>3. Combined Outreach and Societal Sensitivity Development</b>	
# of Summer/Winter Schools and # of Participants	6 (127)
# of other Short/Long Courses at Conferences, etc., and # of Participants	3(80)
# of Tutorials at Conferences, etc., and # of Participants	2(80)



# of Distance Education Courses and # of Participants	0
# of Seminars Series and # of Participants	6(50)
# of Seminars and # of Participants	5(50)
# of Open houses where the work being done by the team is exhibited to colleges, schools, public at large, etc., to increase their understanding and appreciation of research in science and engineering	2
# of Contests held for solving various outreach and societal sensitivity challenges organized by NGO and other organizations from time to time	0
# of Other Institutions in/outside the team impacted by the above	6
# of Major Collaborations with Industry. Describe such collaborations and progress made	5
# of Major Collaborations with Government. Describe such collaborations and progress made	10
# of Major Collaborations with NGOs. Describe such collaborations and progress made.	9
# of Major Collaborations with Any Others. Describe such collaborations and progress made	1
# of Technologies/Solutions/Services/Consultations offered to Industry/Government/NGOs/Others	1
# of Industrial Board Memberships/Licenses/Start-ups	1