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PROGRESS REPORT

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ITRA, Media Lab Asia

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Abbreviations

Sr. No	Abbreviation/Terms	Definition
1	AC	Advisory Council
2	AF	Adjunct Faculty
3	Co-PIs	Co-Principal Investigator
4	DBT	Department of Bio-Technology, Govt. of India
5	EC	Executive Committee
6	EOI	Expression of Interest
7	FP	Full proposal
8	GC	Governing Council
9	IIs	ITRA Institutions –institutions of the research groups that form the teams
10	IPs	Interacting Pyramids – A set of pyramids forming a team working together on different parts of the same problem
11	IT & ICTE	Information Technology & Information and Communication Technologies and Electronics
12	IT-in-X	IT applied to solve problems in an application domain X
13	<i>ITRA-Ag&Food</i>	<i>IT Based Transformations in Indian Agriculture & Food</i> – an IT-in-X focus area of ITRA
14	<i>ITRA-HuSim</i>	<i>ITRA-Human Simulator</i> – the IT-in-X focus area targeted by this RFP
15	<i>ITRA-Mobile</i>	<i>Mobile Computing, Networking and Applications</i> - an IT focus area of ITRA
16	<i>ITRA-Water</i>	<i>IT based Innovations in Water Resources Sustainability</i> - an IT-in-X focus area of ITRA
17	Lead PI	Principal Investigator of the Lead Institution of a pyralet
18	LIN	Lead Institution of a pyralet
19	PI	Principal Investigator – lead of the group from one institution in the pyralet
20	PIN	Partner Institution
21	PRSG	Program Review and Steering Group
22	PSIG	Project Steering and Investigating Group
23	Pyralet	2-layered pyramid of research groups from different institutions
24	R&D	Research and Development
25	RFP	Request for Proposals
26	SFM	Strategy Formulation Meeting
27	TOR	Terms of Reference
28	TOT	Transfer of Technology
29	UG	Under Graduate

Executive Summary

EXECUTIVE.SUMMARY

MISSION STATEMENT: 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 (ICTE, or IT for short) and its applications at a steadily growing number of academic and research institutions across India, 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: Focus areas for conducting research and development are chosen based on national and societal priorities, need assessment, and opportunities. 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, other relevant experts and all stakeholders 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.

SCALABILITY: 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. This leads to an exponential growth in the number of ITRA institutions. The coexisting LIN-PIN interactions simultaneously raise quality across the pyramid with time, while fresh, lowest tier institutions are steadily added at the bottom.

TEAM STRUCTURE: 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 mentor the team from the proposal stage through the actual activities, including motivating research groups, planning and conducting research, guiding students and theses supervision, helping with publications, teaching new classes, evaluating status and discussing/implementing changes, if needed, and general professional guidance. Pooling experts from across the world offers the institutions an opportunity for incorporating the best practices from across the world.

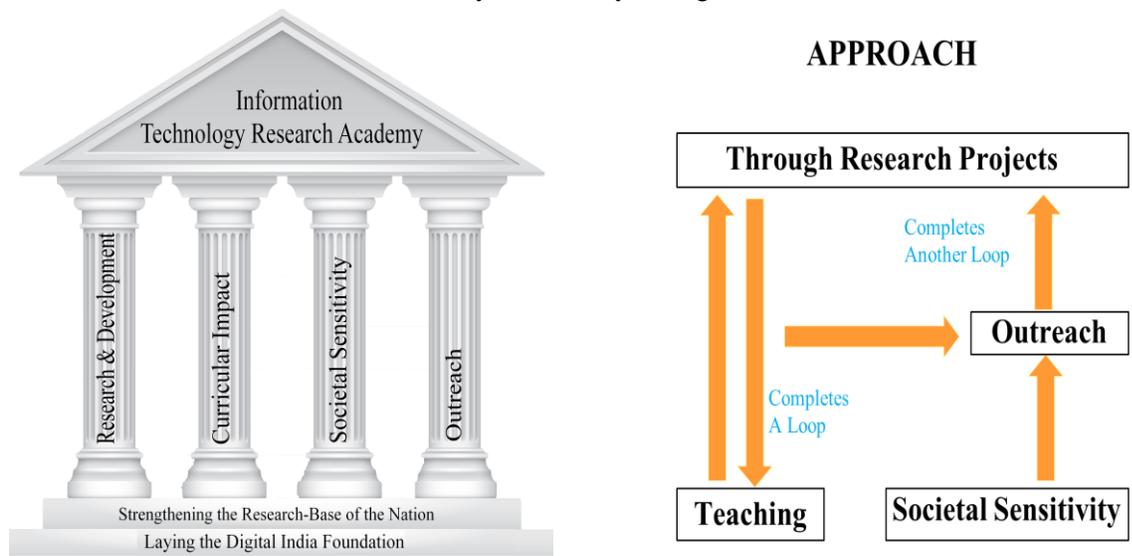
PROPOSAL EVALUATION AND DEVELOPMENT: To maximize the likelihood of a match with ITRA expectations, a two-stage process is used for teams to efficiently develop proposals. In the first stage, a brief Expression of Interest (EOI) statement is submitted by the lead institution of a team, containing a small part of the information needed in a full proposal. This helps ITRA arrive at a preliminary assessment of the proposed effort and provides 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 the thrust of team's proposal, potentially useful groupings among selected teams, etc. The second stage is submission of a full proposal. Those full proposals that are considered promising, are shortlisted for further development. A Full Proposal Development Workshop is conducted in which the shortlisted teams are invited to interact with ITRA, experts and among themselves, to better understand the focus area objectives and what the various other teams are doing, and to identify ways in which they could enhance their proposals so better fit the focus area individually while complementing each other's activities. The enhancements may also include changing the thrusts of the proposals, team structures, and team groupings, etc. The

second stage is submission of a full proposal. The teams are then invited to modify and resubmit their proposals accordingly. This is followed by a series of evaluate-modify steps in which the teams interact with ITRA and experts to iteratively modify the proposals until all identified improvements are incorporated.

POST SELECTION ENGAGEMENT WITH TEAMS: After the teams have been selected, ITRA proactively and continuously work with the teams to identify the needs and opportunities to maximize performance. ITRA arranges for the necessary resources and mechanisms and pyramid-wide access to them. In addition to two intra-team meetings, all teams also meet every 6 months, once for receiving feedback, and once for being evaluated, in Feedback and Evaluation Workshops. Achievements by teams are 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.

FOCUS AREAS TO DATE: 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 38 groups, and in *ITRA-Water*, 5 teams, consisting of 24 groups, are engaged in research and development projects identified in focus area roadmaps. Two more focus areas, “IT Transformations in Indian Agriculture and Food (*ITRA-Ag&Food*)” and “Human Simulator for Amyloids Related Diseases (*ITRA-HuSim*)” have also been initiated.

EXPECTED OVERALL IMPACT: The teams working on related problems from a focus area help with: Building R&D Groups in IT and its Applications; Networking them and connecting them to Industry and Society; Producing high quality PhDs for Industry, R&D labs and Academic Institutions; Enhancing societal problem solving skills, and overall, and Enabling innovation. It is expected that ITRA will help 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. The expected large increase in the national capacity of producing PhDs should help address the shortage of good faculty in academic institutions, and the needs of the industry and society at large.



About ITRA

About ITRA

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.

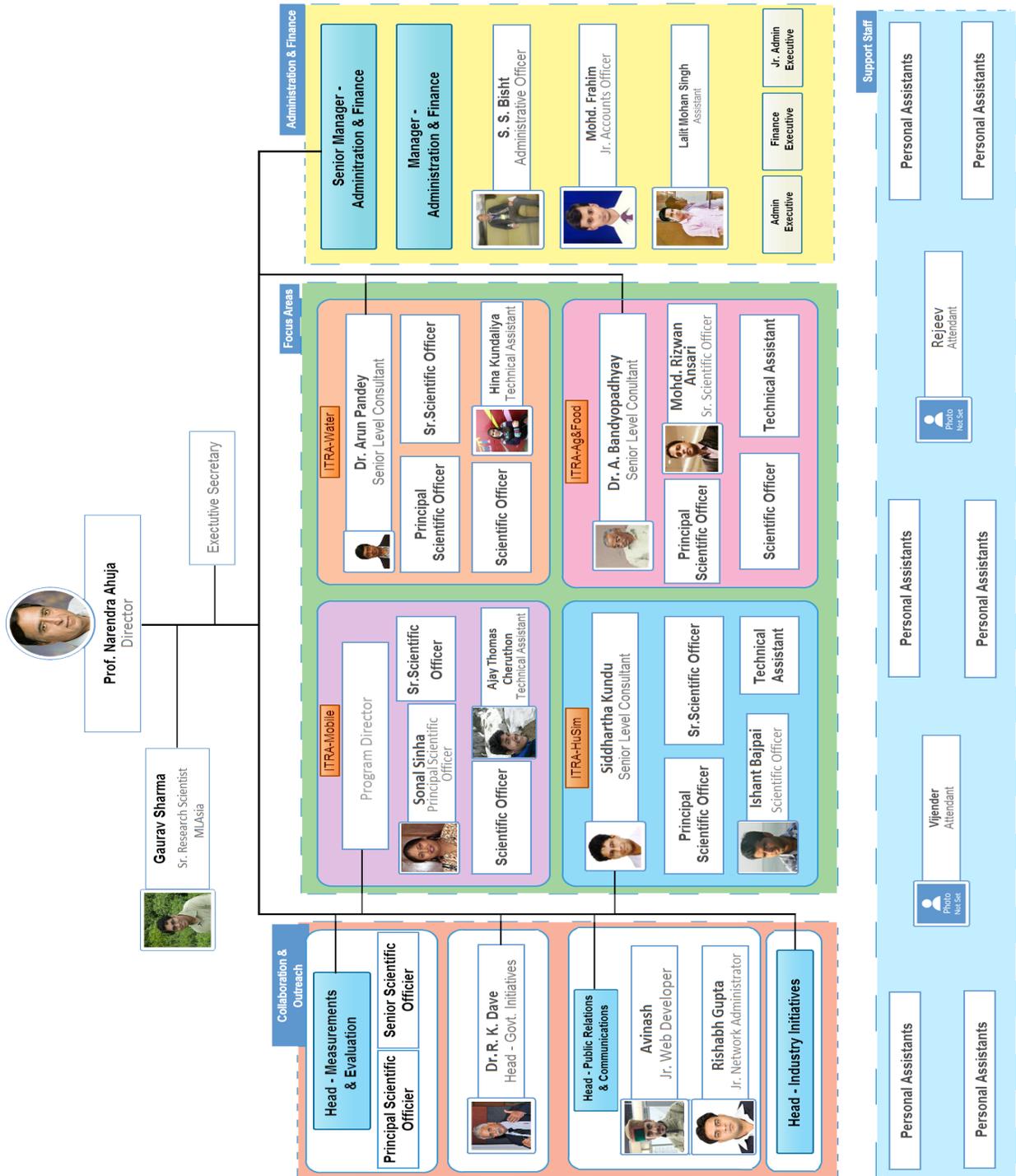
Implementation of the five year 'ITRA project' with a total outlay of Rs. 148.83 Cr was entrusted to Media Lab Asia (MLAsia), a Section-25 not-for-profit organization, by DeitY in November 2010. Initially, ITRA was established for operations through Dec 2015, but this period was subsequently extended till Dec 2018. 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, IIT Madras and ex-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 5-member Project Steering & Implementation Group (PSIG) was constituted initially by DeitY for taking necessary steps for the implementation of the starting phase of the ITRA project. On completion of these steps, DeitY replaced PISG with PRSG to oversee the ITRA project. PRSG makes recommendations to the ITRA Programme Division at DeitY on the decisions that have to do with the government functioning and regulations, including those made as per policies recommended by ITRA AC and approved by ITRA GC. PRSG is chaired by Prof U.B. Desai, IIT Hyderabad and co-chaired by the Group Coordinator at DeitY handing ITRA.

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

ORGANIZATIONAL STRUCTURE



The list of ITRA personnel is placed at ANNEXURE 2.

ITRA Model

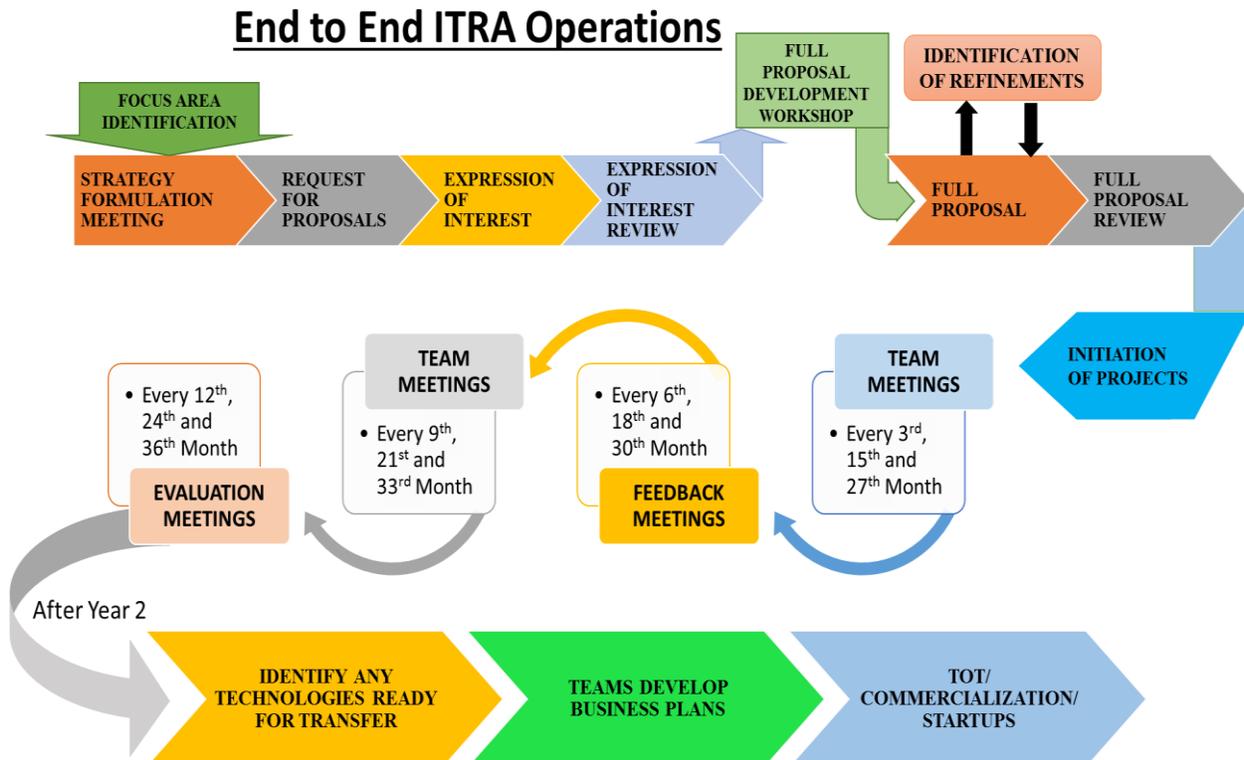
ITRA Model

In pursuit of building a national resource for advancing the quality and quantity of R&D in IT and its applications, ITRA first chooses a Focus Areas with societal relevance for conducting research and development. To begin the pursuit of a selected focus area, a Strategy Formulation Meeting (SFM) with well-known researchers and other relevant experts in the focus area is held to identify and evolve a roadmap for the area. Subsequently through rigorous selection mechanism, 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. A team consists of (i) researchers from academic and research institutions, any additional disciplines needed to pursue the team’s objectives. The nodes of pyramid 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 also include renowned scientists, technologists, industrialists, etc. as mentors who mentor the team from the proposal stage through the actual activities, including planning, publications, theses supervision, and general professional guidance.

After the teams have been selected, ITRA proactively and continuously work with the teams to identify the needs and opportunities to maximize performance. ITRA arranges for the necessary resources and mechanisms and pyramid-wide access to them. Achievements by teams are 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 ITRA quality metrics.

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



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.

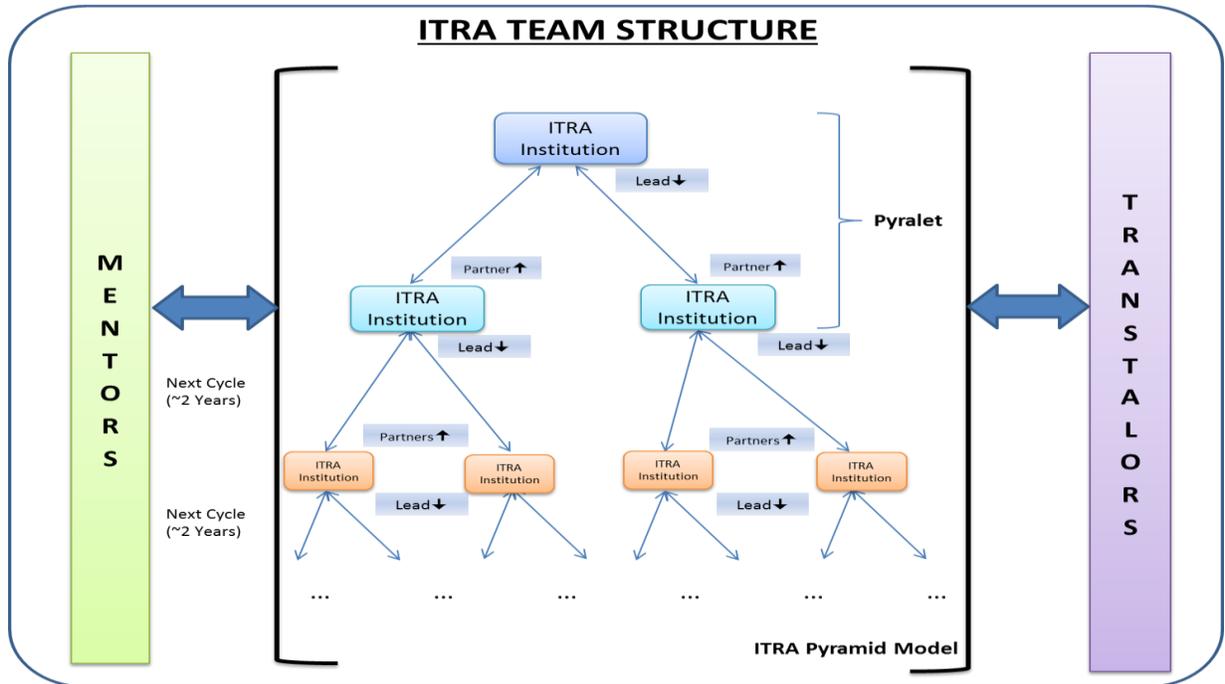
TEAM STRUCTURE

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 has networked these existing institutions as a pyramid. All IIs are Academic Institutions or Government supported Research Laboratories. They form the nodes of a pyramid. These IIs 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 is 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 is addressed by a set of pyramids. The problems are divided into sub problems, and work on each sub problem (S) is undertaken by N (N being one or more) interacting pyramids (IP). The value of N depends on the size/requirements of S. A

more ambitious S may call for a larger number of IPs. Each IP begins 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 distributes and carries 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 is required to add a layer of 2-3 new PINs of its own for whom it will act as LIN.

The pyramid thus grows in chunks, each chunk being the new layer of PINs added at the bottom, thus expanding the pyramid. The expansion is 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 tend to appear in the ITRA pyramids more frequently.



An II typically improves 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 itself grows directly with the number of institutions in the pyramid, i.e., the pyramid size will grow exponentially.

The focus areas are either be disciplines within IT itself, or aimed at applying IT to an important problem domain X, referred to as IT-in-X. ITRA helps 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 primarily flows 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 are established through initial grants. Future layers are added during the same grant, through renewals of these grants or new grants.

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.

POST PROJECT INITIATION ENGAGEMENTS WITH THE TEAMS

ITRA proactively and continuously works with the IIs to identify the needs and opportunities for achieving greater efficiency. ITRA arranges for the necessary resources and mechanisms and pyramid-wide access to them. ITRA and all teams 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 meet every three months, to take stock of the progress and discuss the work that is to follow. After each of these meets, they prepare a quarterly report, to be submitted by the PI to ITRA. The contents of the reports are 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 is a focus area meet aimed at providing feedback to the team. Each team, including PI, Co-PIs, PhD students and other researchers, participate in this meet. A subset of the mentors along with other experts provides 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, is attended by the entire teams, including PI, Co-PIs, PhD students and other researchers, from all focus areas. One objective is to evaluate each team's performance over the preceding year. Based on performance, a panel of mentors and experts makes 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 recognizes 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 third meeting of ITRA Governing Council. The summary of the awards is as follows:

Awards Category	Details
PhD Research Award	<ol style="list-style-type: none"> a) The award will have 2 levels – Exemplary and Outstanding, and will be given annually. b) The number of awards will be up to 5 at Exemplary level (i.e. 5% of the total PhD Students in the focus area) and 25 (i.e. 25% of the total PhD Students in the focus area) at Outstanding level. c) Award amounts will be 2 Lakhs at Exemplary level and 1 Lakh at Outstanding level. d) These awards will be given twice i.e. at end of year 1 and year 2 of the project.
PhD Dissertation Award	<ol style="list-style-type: none"> a) ITRA plans to give PhD Dissertation Awards, in the form of a citation only, without any monetary compensation. 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>c) A citation along with a gold plated medal 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>
Team Achievement Award Grant	<p>a) The award to the teams will be given in 3 categories, corresponding to the following groupings of the ITRA performance metrics: (i) Research, (ii) Curricular Impact, and (iii) Combined Societal Sensitivity and Outreach.</p> <p>b) Up to 1 team per category per focus area may be selected for the award per year.</p> <p>c) The award will have 2 levels – Exemplary and Outstanding.</p> <p>d) The award grant amount will be either Rs. 10 Lakhs (for Outstanding level) or Rs. 20 Lakhs (for Exemplary level).</p> <p>e) These awards will be given twice i.e. at end of year 1 and year 2 of the project.</p>
Foresight Award Grant	<p>a) Up to 1 team per focus area may be selected for the award.</p> <p>b) The award grant amount will be Rs. 10 Lakhs.</p> <p>c) This award will be given once at the time of approval of projects, i.e. in year 1.</p>
Partnership Achievement Grant	<p>a) The award will have 2 levels – Exemplary and Outstanding.</p> <p>b) The number of LIN-PIN pairs to be selected will be up to 1 at Exemplary level (i.e. 5% of institutions in a focus area), and up to 4 at Outstanding level (i.e. 15% of institutions in a focus area).</p> <p>c) Award amounts will be: Rs. 6 Lakhs at Exemplary level and Rs. 3 Lakhs at Outstanding level.</p> <p>d) These awards will be given twice i.e. at end of year 1 and year 2 of the project.</p>
Interdisciplinary Collaboration Award Grant	<p>a) The award will have 2 levels – Exemplary and Outstanding.</p> <p>e) The number of awardee pairs to be selected will be up to 1 at Exemplary level (i.e. 5% of institutions in a focus area), and up to 4 at Outstanding level (i.e. 15% of institutions in a focus area).</p> <p>b) Award amounts will be: Rs. 6 Lakhs at Exemplary level and Rs. 3 Lakhs at Outstanding level.</p> <p>c) 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.

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

ITRA Focus Area

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 38 groups, and in *ITRA-Water*, 5 teams, consisting of 24 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: MOBILE COMPUTING, NETWORKING AND APPLICATIONS

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.

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. 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 and Achievements made so-far by the teams of *ITRA-Mobile* are as follows:

Summary of the Quantitative Measures of the Progress Achieved by Nine Mobile Teams

Area	Year 1
1. Research and Development	
# of Publications in Peer Reviewed Conferences included in the ITRA List or of the same Calibre	180
# of Publications in Major Peer Reviewed Journals included in the ITRA List or of the same Calibre	42
# of Peer Reviewed Conferences in which Project Personnel are Organizers (e.g., as Chairs, Reviewers, Committee Members, ..)	104
# 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,)	43
# of invited talks given at major institutions, conferences	61
# of PhD students in the project	76
# of Masters students	72
# of Undergrad students	46
# of students supported to travel to conferences	31
# of Post-Docs	2
# 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	7
2. Impact on Curriculum	
# of New Courses/Modules developed	26
# of New Labs	8
# of Courses/Modules updated in a major way	7
# of Labs Updated in a major way	14
# of New Textbooks authored	5
# of Other Institutions inside/outside the team impacted by the above	7

3. Combined Outreach and Societal Sensitivity Development	
# of Summer/Winter Schools and # of Participants	22 & 800
# of other Short/Long Courses at Conferences, etc., and # of Participants	19 & 300
# of Tutorials at Conferences, etc., and # of Participants	3
# of Distance Education Courses and # of Participants	4
# of Seminars Series and # of Participants	3 & 50
# of Seminars and # of Participants	12
# 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	52
# of Contests held for solving various outreach and societal sensitivity challenges organized by NGO and other organizations from time to time	3
# of Other Institutions in/outside the team impacted by the above	1
# of Major Collaborations with Industry. Describe such collaborations and progress made	11
# of Major Collaborations with Government. Describe such collaborations and progress made	9
# of Major Collaborations with NGOs. Describe such collaborations and progress made.	3
# of Major Collaborations with Any Others. Describe such collaborations and progress made	7
# of Technologies/Solutions/Services/Consultations offered to Industry/Government/NGOs/Others	1
# of Industrial Board Memberships/Licenses/Start-ups	7

ITRA-WATER: IT BASED INNOVATIONS IN WATER RESOURCES SUSTAINABILITY

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 Strategy Formulation Meeting (SFM) for *ITRA-Water* 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. 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 collaborative. In this context, IT is interpreted broadly as cyber infrastructure 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.

Based on the SFM report, a RFP document was created. As per the team selection mechanism, 5 team projects consisting of 24 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 and the Achievements made so-far by the teams of *ITRA-Water* are as follows:

Summary of the Quantitative Measures of the Progress Achieved by Five Water Teams

Area	Year 1
1. Research and Development	
# of Publications in Peer Reviewed Conferences included in the ITRA List or of the same Calibre	38
# of Publications in Major Peer Reviewed Journals included in the ITRA List or of the same Calibre	32
# of Peer Reviewed Conferences in which Project Personnel are Organizers (e.g., as Chairs, Reviewers, Committee Members, ...)	49
# 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,)	42
# of invited talks given at major institutions, conferences	46
# of PhD students in the project	30
# of Masters students	26
# of Undergrad students	32
# of students supported to travel to conferences	6
# of Post-Docs	1
# of Tools/Technologies developed	10
# of Technical contests held for solving various technical/other field-relevant challenges organized by professional societies and other organizations from time to time	19
2. Impact on Curriculum	
# of New Courses/Modules developed	15
# of New Labs	12
# of Courses/Modules updated in a major way	5
# of Labs Updated in a major way	10
# of New Textbooks authored	8
# of Other Institutions inside/outside the team impacted by the above	4

3. Combined Outreach and Societal Sensitivity Development	
# of Summer/Winter Schools and # of Participants	9 & 175
# of other Short/Long Courses at Conferences, etc., and # of Participants	10 & 150
# of Tutorials at Conferences, etc., and # of Participants	2 & 80
# of Distance Education Courses and # of Participants	0
# of Seminars Series and # of Participants	7 & 60
# of Seminars and # of Participants	9 & 460
# 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	8
# of Contests held for solving various outreach and societal sensitivity challenges organized by NGO and other organizations from time to time	2
# of Other Institutions in/outside the team impacted by the above	6
# of Major Collaborations with Industry. Describe such collaborations and progress made	7
# 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	32

ITRA-AG&FOOD: IT BASED TRANSFORMATIONS IN INDIAN AGRICULTURE AND FOOD

The prime objective of *ITRA-Ag&Food* is to 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.

SFM for the area *ITRA-Ag&Food* was 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. The agriculture and food problems were 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, and 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.

Activities undertaken for selection of proposals:

- i. Request of Proposals (RFP) was developed and floated in Nov 2014 based on the recommendations of Strategy Formulation Meeting held in Mar 2013. In response of this RFP, ITRA received a total of 219 EOIs.
- ii. These EOIs were reviewed by a panel of domain experts, who shortlisted 26 EOIs and recommended them to be clubbed into 18 Full Proposals (FPs).
- iii. These teams were called for a full proposal development meeting in May 2015 to maximize the quality of the final proposals, and coverage of the RFP topics by the shortlisted teams. The teams were asked to modify their FPs to cover the *ITRA-Ag&Food* focus area well and re-submit.
- iv. The revised FPs were evaluated by a Review Panel who classified them into five categories of merit. Another proposal on post-harvest losses, developed in consultation with ITRA with external funding possibility, was also reviewed and shortlisted.
- v. 12 projects covering the top 3 categories were presented in the last EC meeting held in Nov 2015, where EC suggested some modifications in the 10 proposals and recommended these 10 proposals (including the post-harvest loss proposal) to be processed further. 2 proposals were recommended to be funded under North-East budgetary component.
- vi. Out of these 10 proposals, the 9 proposals that were selected at the EOI stage are being taken up with the EC again. EC recommended 8 proposals to be funded under *ITRA-Ag&Food*, if funds were available. One remaining proposal was referred back to the review panel, as it had some change in team structure.

ITRA-HUSIM: HUMAN SIMULATOR FOR AMYLOIDS RELATED DISEASES

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-HuSim* 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.

Activities undertaken for selection of proposals:

- i. Request of Proposals (RFP) was developed and floated in Mar 2015 based on the recommendations of Strategy Formulation Meeting held in Jan 2015. In response of this RFP, ITRA received a total of 32 EOIs.
- ii. These EOIs were reviewed by a panel of domain experts, who shortlisted 23 EOIs and submit their FPs.
- iii. In response 21 FP/teams were called for a full proposal development meeting in Sep 2015 to maximize the quality of the final proposals, and coverage of the RFP topics by the shortlisted teams. The teams were asked to modify their FPs to cover the *ITRA-HuSim* focus area well and re-submit.

- iv. The revised FPs were evaluated by online reviewers. Based on the reviews, the FPs were classified into two groups. 4 proposals in the first group, which received the best reviews, were decided to be invited for a presentation before a Review Panel. The second group had remaining 17 FPs, were asked to resubmit their proposals based on reviewers' comments.
- v. A teleconference with representatives from the 17 teams was conducted in Feb 2016. Teams were given feedback on their proposals and were asked to revise and resubmit their proposals.
- vi. 4 teams made presentation before the Review Panel in Feb 2016. 1 FP was shortlisted for further processing, 2 FPs were asked for revisions and resubmission, and the last remaining FP was rejected.

ITRA Activities, Milestones and Achievements

Activities undertaken by ITRA: 2010 – 2016

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 st installment of funds	→ Rs. 14.33 Crs as 1 st installment 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 finalized and approved.
Jun 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, <i>ITRA-Mobile</i> : Mobile computing, Networking and Architecture, and <i>ITRA-Water</i> : 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) finalized 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 <i>ITRA-Water</i>	→ The meeting was attended by 50+ experts from academia, government and industry, from India as well as abroad. This SFM identified the following themes: <ul style="list-style-type: none"> - Improving Hydro-Meteorological Prediction for Economic Development - Improving GW 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 <i>ITRA-Mobile</i>	<p>→ The meeting was attended by 50+ participants from academia, government and industry, from India as well as abroad. This SFM identified the following themes:</p> <ul style="list-style-type: none"> - Communication Theory - Network Theory - Graph Theory - Dependable Systems - Communication Protocols - Operating Systems
Dec 2011	RFP's floated for <i>ITRA-Water</i> and <i>ITRA-Mobile</i>	→ Requests for Proposals (RFP) for both focus areas were prepared and circulated.
Jan 2012	Constitution of ITRA – GC and AC	<p>→ 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.</p> <p>→ ITRA AC was setup with the approval of Hon'ble MCIT and is chaired by Prof. S. V. Raghavan, Scientific Secretary, and 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.</p>
Feb – Apr 2012	Processing of proposals submitted for <i>ITRA-Mobile</i> and <i>ITRA-Water</i>	<p>→ The last date of receiving Expression of Interests was end of Jan 2012.</p> <p>→ For <i>ITRA-Water</i> – 30 EoIs and for <i>ITRA-Mobile</i> – 64 EoIs were submitted by deadline.</p> <p>→ 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.</p>
Apr 2012	Meeting of ITRA AC	<p>→ Ratification of the areas already initiated: <i>ITRA-Mobile</i> and <i>ITRA-Water</i></p> <p>→ Probable candidates for new focus areas presented</p> <p>→ Food and Agriculture domain was recommended</p>
May – Oct 2012	Processing of proposals submitted for <i>ITRA-Mobile</i> and <i>ITRA-Water</i>	<p>→ FP Submissions were due in late May 2012 for both <i>ITRA-Mobile</i> and <i>ITRA-Water</i></p> <p>→ Review of FPs was done online by experts;</p> <p>→ Teams were asked to incorporate comments of the experts and re-submit their FPs by Oct 2012.</p>
Feb – Sep 2012	Drafting Technical/ Administrative/ Financial guidelines/ policies for ITRA	<p>→ PSIG drafted guidelines for Selection of Focus Areas; Proposal Submission, and Evaluation & Award Processes.</p> <p>→ Policy documents specifying recruitment rules and organizational structure were also drafted.</p>
Oct 2012	Meeting of ITRA GC	→ Various policies / guidelines as drafted by PSIG were approved in this meeting.
Nov 2012	Review Panel Meeting of <i>ITRA-Mobile</i> 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 <i>ITRA-Ag&Food</i>	<ul style="list-style-type: none"> → Meeting was conducted on the subject of IT in Agriculture and Food with various scientists/faculty from ICAR, IIT-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 program.
Feb 2013	Review Panel Meeting of <i>ITRA-Water</i> 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	<ul style="list-style-type: none"> → PIs of shortlisted <i>ITRA-Mobile</i> and <i>ITRA-Water</i> projects presented their proposal. → EC recommended some technical/ financial modifications and resubmit FPs
Mar 2013	SFM on <i>ITRA-Ag&Food</i>	<ul style="list-style-type: none"> → SFM was attended by 80+ National and International IT, Agriculture and food experts. This SFM identified the following themes where IT can intervene: <ul style="list-style-type: none"> - Crop production; - Agriculture education and extension; - Livestock and fisheries - Soil, water and weather; - Marketing and agri-business; and
May 2013	Meeting of ITRA EC	<ul style="list-style-type: none"> → PIs of shortlisted <i>ITRA-Water</i> projects presented their proposal. → EC recommended some technical/ financial modifications and resubmit FPs → Recommended 9 Mobile and 7 Water projects for award
May-Jul 2013	Brainstorming meetings on various probable focus areas	<ul style="list-style-type: none"> → Brain storming meeting on '<i>ITRA-BIO: Acquisition, Understanding and Application of Biomedical Data</i>' 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 organized a meeting on '<i>Challenges in Genomics and Computing</i>' during July 22-24, 2013 at Bangalore. This meeting was attended by more than 50 national and international domain experts.
Jul 2013	Meeting of ITRA AC	<ul style="list-style-type: none"> → 7 new probable focus areas were presented. → AC prioritized those areas → AC suggested that ITRA pick two areas to pursue in the near future, the rest to be considered subsequently.

Sep 2013	Brainstorming meetings on various probable focus areas	<p>→ Brain storming meeting on <i>Robust Electronics</i> was conducted on Sep 24, 2013 at New Delhi which was attended by 10 domain experts to prepare a white paper on the subject.</p> <p>→ Brain storming meeting on <i>Computational Fluid Dynamics</i> was conducted on Sep 27, 2013 at New Delhi which was attended by 10 domain experts to prepare a white paper on the subject.</p>
Sep 2013	Award of Projects	<p>→ 14 team projects worth Rs. 39 Crs were awarded with the approved of Hon'ble MCIT.</p> <p>→ 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.</p>
Oct 2013	Release of second installment of funds to ITRA	→ Rs. 16.27 Crs were released to MLAsia as second installment of funds for ITRA projects.
Nov 2013	Policy for post project award engagement with teams	<p>→ 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.</p> <p>→ Subsequently framework was framed for:</p> <ul style="list-style-type: none"> - ITRA Awards for students and teams - Interactions of ITRA Teams with Mentors - International Travel of ITRA Researchers - Adjunct Faculty Scheme - Attracting New Faculty
Dec 2013	Meeting of ITRA AC	<p>→ Two themes of national significance and need that may run through the detailed topics recommended at the 2nd AC meeting were discussed.</p> <p>→ 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.</p>
Dec 2013	Meeting of ITRA EC	→ 3 rd meeting convened to plan ITRA project launch workshop and discuss ITRA's extension.
Jan 2014	Formal launch of <i>ITRA-Mobile</i> and <i>ITRA-Water</i> Projects	<p>→ 14 team multi-disciplinary, collaborative, multi-institutional R&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.</p> <p>→ All teams were briefed about ITRA's objectives, and methodology.</p>
Apr 2014	Meeting of ITRA GC	<p>→ Draft policy for post project award engagement with teams, ITRA extension, and new focus areas, were presented in the 2nd meeting of GC.</p> <p>→ A sub-committee was constituted for formulating the policy for post project award engagement with teams.</p>

May - July 2014	Meeting of Sub-committee of GC	<p>→ Sub-committee drafted the schemes and policies for:</p> <ul style="list-style-type: none"> - UG and PG Student Internships - Performance Based Awards for Students and Teams - Interactions of Teams with Mentors - International Travel of Researchers - Interactions of Teams with Adjunct Faculty <p>→ Approved by Chairman – GC in Aug 2014</p> <p>→ Approval of DeitY was sought for implementation of the same in Aug 2014.</p> <p>→ IFD/DeitY recommended to seek approval in ITRA GC’s next meeting</p>
Aug 2014	Feedback Workshops of <i>ITRA-Water</i> and <i>ITRA-Mobile</i> projects	<p>→ Feedback workshop held in Bangalore to review and provide feedback to <i>ITRA-Water</i> teams.</p> <p>→ Feedback workshop held in Delhi to review and provide feedback to <i>ITRA-Mobile</i> teams.</p>
Oct 2014	Meeting of ITRA GC	<p>→ 3rd 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</p> <p>→ All schemes and policies were approved.</p> <p>→ Recommended to seek one-time dispensation of Dept. of Expenditure for all international travel.</p> <p>→ Recommended mid-term review of the functioning of ITRA, before seeking extension.</p> <p>→ Approved plans for new focus area.</p> <p>→ Asked ITRA to constitute a committee to formulate policy on external funding.</p>
Oct 2014	Meeting of PRSG	<p>→ PRSG for ITRA project constituted by DeitY under chairmanship of Prof UB Desai, Director, IIT Hyderabad</p> <p>→ 1st meeting convened to oversee the progress of ITRA.</p> <p>→ PRSG recommended the following:</p> <ul style="list-style-type: none"> - Revise targets of PhD students to 250 instead of 480. - Seek approval on international travel of ITRA researchers from PRSG on case to case basis - Release 30 Crs to MLAsia as next installment of GIA to ITRA project.
Nov 2014	Brainstorming Meeting for <i>ITRA-HuSim</i>	<p>→ 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.</p>
Nov 2014	RFP for <i>ITRA-Ag&Food</i>	<p>→ RFP for the focus areas were prepared and circulated.</p>

Dec 2014	Meeting of ITRA EC	<p>→ 4th 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</p> <p>→ EC recommended the following:</p> <ul style="list-style-type: none"> - 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.
Dec 2014 – Jun 2015	Dispensation from Dept. of Expenditure (DOE) for supporting foreign travel of ITRA Mentors	<p>→ As per directions of Governing Council, ITRA worked in tandem with the programme division at DeitY for seeking the dispensation from DOE for supporting foreign travel of 350 ITRA Mentors.</p> <p>→ After multiple iterations of notings from DOE, approval for supporting 14 mentor visits till Dec 2015 was accorded.</p>
Jan 2015	Evaluation Workshop for <i>ITRA-Mobile</i> and <i>ITRA-Water</i>	<p>→ The Annual Evaluation Meeting of <i>ITRA-Water</i> and <i>ITRA-Mobile</i> was conducted in January, 2015.</p> <p>→ 14 team projects were reviewed by panels of 10 to 15 experts in the respective fields.</p> <p>→ Students presented posters for their respective projects. A total of 72 posters (33 for <i>ITRA-Water</i> and 39 for <i>ITRA-Mobile</i> projects) were presented during the course of the workshop.</p>
Jan 2015	SFM for <i>ITRA-HuSim</i>	<p>→ SFM on 'Human Simulator for Amyloids related Diseases' conducted in January, 2015. Participated by 60+ national and international experts, from the fields of Medicine and ICT&E.</p>
Feb – May 2015	Processing of proposals submitted for <i>ITRA-Ag&Food</i>	<p>→ In response to the RFP floated, ITRA received 200+ EOIs by the deadline of Feb 1, 2015.</p> <p>→ These EoIs were reviewed by a panel of domain experts on basis of their quality, national importance and readiness of the proposal.</p> <p>→ The review panel shortlisted 47 EoIs for further consideration.</p> <p>→ An EoI Evaluation Meeting was conducted in April, 2015 during which the panel shortlisted 26 EoIs to be merged into 18 FPs in order to avoid overlapping in topic of importance.</p>
Mar 2015	RFP for <i>ITRA-HuSim</i>	<p>→ RFP for the focus areas were prepared and circulated.</p>
Mar 2015	Release of 3 rd installment to ITRA	<p>→ Rs. 8 Crs were released to MLAsia as third installment of funds for ITRA projects.</p>
Apr 2015	Meeting of PRSG	<p>→ 2nd Meeting convened to discuss: Status of ITRA project; Modifications in existing <i>ITRA-Mobile</i> and <i>ITRA-Water</i> teams; ITRA project extension; Interaction and collaboration with UNESCO.</p> <p>→ PRSG recommended the following:</p> <ul style="list-style-type: none"> - Endorsed the recommendations made by Review Panel during Evaluation Workshop 2015 regarding changes/alteration in team structure.

		<ul style="list-style-type: none"> - To convene PRSG meeting preferably in May 2015, specifically for review of ITRA activities before recommending ITRA extension - Approved interaction and collaboration with UNESCO
Apr – Aug 2015	Processing of proposals submitted for <i>ITRA-HuSim</i>	<ul style="list-style-type: none"> → 32 EOIs received by the deadline of Apr 19, 2015 → Scrutiny of EoIs: 9 EoI teams were rejected as they did not meet one or more RFP criteria, Remaining 23 EOI teams were screened in for further processing → Review of EoIs: These EOIs were reviewed by a panel of domain experts, who shortlisted 23 EOIs and submit their FPs. → In response only 21 EoI Teams submitted their full proposals
Apr 2015	Meeting of ITRA EC	<ul style="list-style-type: none"> → The fifth executive committee held to discuss: (i) Current status of ITRA; (ii) International travel funding; (iii) Formation of PI committees; (iv) Budgets for new institutions and enhanced budgetary requirements of existing institutions; (v) ITRA’s extension → EC recommended the following: <ul style="list-style-type: none"> - ITRA project be extended up to March 31, 2019. - Approved constitution of ITRA PI Committees for: Inter-Institutional Affairs; Faculty Talent acquisition; International Programs; Technology Transfer; Organization of ITRA Meetings; Development of Societal Sensitivity Programs - Addition of the new PINs, to existing institutions. - Revision in project outlays, due to increase in fellowship amounts and outreach activities, and transfer international travel funds to the teams, of existing institutions may be taken up with competent authority.
May 2015	PRSG Meeting	<ul style="list-style-type: none"> → The Third PRSG meeting convened to discuss (i) ITRA’s status; (ii) Extension of ITRA term; → PRSG recommended the extension of ITRA project up to March 31, 2019
May 2015	Governing Council Meeting	<ul style="list-style-type: none"> → The fourth GC meeting was convened to discuss: Status of ITRA activities; and Extension of ITRA. → GC recommended the extension of ITRA up to Dec 31, 2018.
May 2015	Full Proposal Development Meeting for <i>ITRA-Ag&Food</i>	<ul style="list-style-type: none"> → ITRA invited 18 teams to the Full Proposal development Meeting for further refining the shortlisted proposals. → On basis of review panel’s recommendations, these teams revised their FP’s and re-submitted to ITRA by deadline of 24th July, 2015 for further consideration.
Jul 2015	Mid-Year Review for <i>ITRA-Water</i>	<ul style="list-style-type: none"> → The Mid-Year Evaluation Meeting of <i>ITRA-Water</i> was conducted at Univ. of Hyderabad campus. → 5 team projects reviewed by panels of more than 10 experts in the respective fields.

		<p>→ Students presented posters for their respective projects, and other discussions on Cleaning Ganga, Open Data Access in the Context of ITRA Projects, and Ideas for Outreach were discussed.</p> <p>→ The workshop was concluded with the feedbacks from the panel to the teams.</p>
Aug 2015	Mid-Year Evaluation Meeting for <i>ITRA-Mobile</i>	<p>→ The Mid-Year Evaluation Meeting of <i>ITRA-Mobile</i> was conducted in Delhi.</p> <p>→ 8 team projects were reviewed by panels of more than 10 experts in the respective fields.</p> <p>→ Students presented posters for their respective projects, and other discussions were held on technical challenges being faced by Ola Cabs, and Role of Mobile Computing and Networking for Disaster Management in the context of ITRA projects, and Ideas for Outreach were discussed.</p> <p>→ The workshop was concluded with feedbacks from the panel to the teams.</p>
Aug – Nov 2015	Shortlisting of proposals under <i>ITRA-Ag&Food</i>	<p>→ The revised 18 FPs were reviewed again during the review panel meeting held on Aug 5-6, 2015.</p> <p>→ The review panel shortlisted 11 proposals keeping in view the proposal quality and value of the proposed deliverables</p>
Sep - Oct 2015	Full proposal development meeting for <i>ITRA-HuSim</i>	<p>→ All 21 FP/teams were called for a full proposal development meeting in Sep 2015, to maximize the quality of the final proposals, and coverage of the RFP topics.</p> <p>→ Domain experts reviewed the R&D plans of the teams and gave feedback to modify their respective full proposals and re-submit by end of Oct 2015.</p>
Nov 2015	Meeting of PRSG	<p>→ The fourth PRSG meeting convened to discuss technical and financial status of ITRA</p> <p>→ Based on satisfactory performance by ITRA, PRSG recommended release of next installment of GIA to MLAsia towards ITRA project, and extension of international travel support to ITRA mentors till March 2016</p>
Nov 2015	Meeting of ITRA EC	<p>→ 6th Executive Committee meeting convened to discuss proposals under <i>ITRA-Ag&Food</i> initiative</p> <p>→ EC prioritized them on the basis of their proposal quality and value of the proposed deliverables. EC authorized ITRA to review and revise financials of the proposals.</p>
Nov 2015 – Mar 2016	Processing of proposals submitted for <i>ITRA-HuSim</i>	<p>→ The revised FPs were evaluated by online reviewers. Based on the reviews, the FPs were classified into two groups:</p> <ul style="list-style-type: none"> - 4 proposals in the first group, which received the best reviews. These teams made presentation before the Review Panel in Feb 2016, where 1 FP was shortlisted for further

		<p>processing, 2 FPs were asked for revisions and resubmission, and the last remaining FP was rejected.</p> <ul style="list-style-type: none"> - The second group had remaining 17 FPs, A teleconference with their representatives was conducted in Feb 2016. Teams were given feedback on their proposals and were asked to revise and resubmit their proposals.
Dec 2015	Extension for providing international travel support towards mentorship visits	→ Based on PRSG's recommendations, DeitY accorded extension for supporting international travel of the 14 listed ITRA mentors till March, 2016
Dec 2015	Release of 4 th installment to ITRA	→ Rs. 955.83 Crs (including NE) were released to MLAsia as fourth installment of GIA for ITRA projects.
Jan 2016	Evaluation Workshops for <i>ITRA-Mobile</i> and <i>ITRA-Water</i> project	<p>→ The second evaluation meeting of <i>ITRA-Water</i> and <i>ITRA-Mobile</i> projects were conducted in January, 2016.</p> <p>→ 14 team projects were reviewed by panels of 15 to 17 experts in the respective fields. Students presented posters for their respective projects.</p> <p>→ A total of 103 posters (38 for <i>ITRA-Water</i> and 65 for <i>ITRA-Mobile</i> projects) were presented during the course of the workshop.</p>
Feb 2016	Meeting of ITRA EC	→ 7th Executive Committee meeting convened to discuss proposals for <i>ITRA-Ag&Food</i> initiative. EC took note of the revisions made by the shortlisted <i>ITRA-Ag&Food</i> proposal teams and found them in line with the suggestions made in its last meeting. After a detailed discussion on each of the proposals, EC recommended 8 teams for funding under <i>ITRA-Ag&Food</i> initiative.

Current Status vis-a-viz DPR Targets

Parameters	Final Target (DPR)	Achieved
Participating Institutions	40	50
Large Research Institutions	20	17
Small Research Institutions	40	45
ITRA Faculty	74	105
Adjunct Faculty	51	0
PhD Students (Students and Lecturers)	250*	120

* Targets revised by PRSG from 480 to 250

Achievements

To achieve its objectives, ITRA identified the main characteristics of the Indian environment, and designed an R&D model accordingly. This model involves (i) an exponentially growing ecosystem of teams of (ii) tightly interlinked academic institutions, research labs, and government, industrial, international and other organizations; (iii) integrated by the theme of solving problems in an important focus area; (iv) while being mentored by eminent researchers and industry. In the pilot:

- a. ITRA has identified four focus areas of R&D and associated problem solving, two of which have been initiated, and two are being initiated.
- b. Each area involves launching seed teams, each to work on a 3-year project.
- c. The initiated half of the resulting pilot-ecosystem, after two of the three project years has:
 - i. 60 research groups (16 - Tier 1 institutions and 34 – Tier 2 and Tier 3 institutions)
 - ii. 100 faculty/researchers
 - iii. 120 PhD students (to grow in Year 3 of Mobile and Water projects)
 - iv. 33 Mentors (eminent researchers) from India and abroad, and 10 Translators (research to industry)
 - v. Led to 290 research publications, 40 new/modified courses, 60 workshops, 11 researchers deputed abroad for international interactions and exposure
- d. 10 *ITRA-Ag&Food* teams from 53 research groups are ready to be launched as soon as funds are made available.
- e. 19 *ITRA-HuSim* team proposals are being iteratively developed and evaluated with the help of eminent experts as mentors
- f. 15-18 technologies are in advanced stages of development (which are likely to lead to ToT / Commercialization / Start-ups). Some of such technologies are listed below:

ITRA-Mobile

- i. A smartphone based system for real time bus information, remote collision detection, and pre-collision vehicle path forensics
- ii. An automated system to sense, analyse, conserve and provide advice for enhancing home energy usage
- iii. A smartphone accessory kit to watch ECG and PPG
- iv. A smartphone kit to serve as a LINUX PC to experiment with theoretical concepts, by allowing freedom to combine different hardware interfaces, Operating Systems, and applications, e.g., for teaching Embedded Systems, Communication Systems, Mobile Computing and IOT
- v. A dynamically configured wireless system to establish communication among small radio units located on off-shore fishing boats, and between boat-clusters and shore
- vi. An information portal continuously updated to guide fishermen offshore (e.g., by providing detected locations, types and sizes of fish schools) and to disseminate offshore information (latest market demand, price) to help fisherman direct their effort to the available right catches
- vii. A new directional antenna (minimizing energy that would otherwise be wasted in transmission in irrelevant directions) for low power communication from offshore boats to shore
- viii. A smartphone based system to analyse cough characteristics
- ix. A hardware and software system for telemedicine kiosks/mobile units -- including communication with remote doctors, through cloud, and information entry interfaces suitable for operation by unskilled -- to take healthcare to the door of every citizen, including in rural areas, at negligible cost, using a mobile healthcare system prototype designed to function under rural Indian conditions, along with a minimal campaign on why all should take advantage of it
- x. A service to establish ad hoc communication networks at short notice in disaster-struck areas by scatter-deploying mobile phones and interlinking them

ITRA-Water

- i. A hardware/software platform to integrate Sensors, human-provided information, computational models and wireless communications to manage crop resources
- ii. A system for detecting and estimating the size of ground water resources in hard rock aquifers of India
- iii. A service to forecast, analyse the effect of, and manage urban floods, and to design water drainage networks
- iv. A system for sensing and wirelessly disseminating consumer water quality (contamination) and flow (leakage) of information in large urban water distribution networks
- v. A service to optimally locate water recharge sites and tube wells

Financials

Financials

A. Summary (as on 31st March, 2016)

1.	Total funds released so far by DeitY	Rs.50.92 Cr
2.	Interest Adjusted in release	Rs. 2.76 Cr
3.	Total funds including Interest	Rs. 50.92 Cr
4.	Total amount spent so far	Rs. 44.26 Cr
5.	Balance Available	Rs. 6.66 Cr
6.	Commitments:	Rs. 82.93 Cr
	A. Ongoing Projects	
	- ITRA-Mobile Projects	- Rs. 12.37 Cr
	- ITRA-Water Projects	- Rs. 5.56 Cr
	B. Projects to be funded	
	- ITRA-Ag&Food Projects	- Rs. 50.00 Cr
	- ITRA-HuSim Projects	- Rs. 15.00 Cr

B. Head wise Break-up of Expenditure

	Budget head	Amount (in INR Lakhs)
1	R&D Facilities & Prototyping	2974
2	Adjunct Faculty Salary & fellowships	
3	ITRA HQ, DeitY Coordination & Workshops	987
4	Misc & Contingency	465
5	Grand Total	4426

Conclusions and Next Steps

Conclusions and Next Steps

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 experience with these so far has helped refine many of the (i.e. early parts) of the model, but it has mostly provided an opportunity to work out 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, some engagement of technology translation agents, and geographical spread have been encouraging. The model appears to be promising.

There are two major steps ITRA could take next to take advantage of the base work done so far. First, ITRA could complete implementing the remaining features of the model (Items 1 and 2 below). These features are yet to be implemented since they take three years. Second, and in parallel, ITRA could also apply the model in more areas (Items 3 and 4 below).

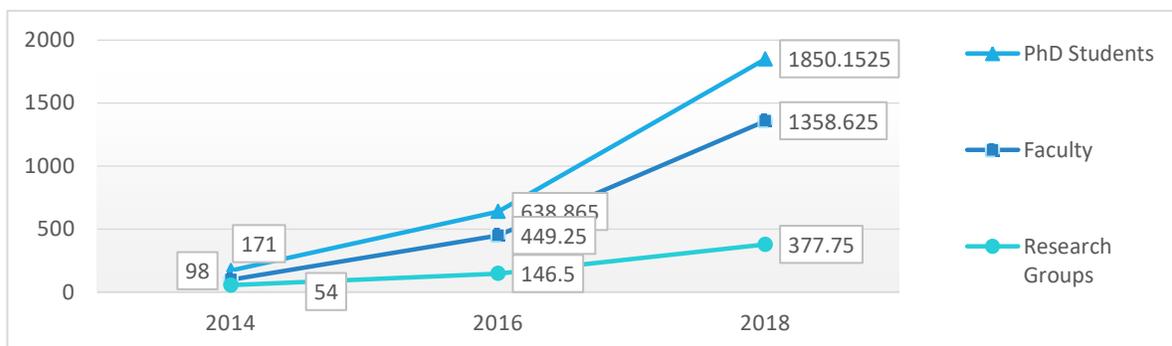
- 1 Technology Transfer (including through possible Start Ups:** The outreach part of ITRA's four quality metrics is concerned with taking the outputs of the R&D to the field. While this metric is continuously used to measure team performance, consolidation and conversion of these results into a field-ready version remains to be done. This would involve completing evaluation of the technologies; exploring different transfer options, including start-ups; addressing the different components (technology, finance, management, marketing,...); and eventually helping launch the survivors.
- 2 Deepening the Pyramids:** One important feature of the ITRA model that is yet to be implemented is the exponential growth of the R&D community with time. Since the first set of ITRA projects was initiated on Jan 1, 2014, and will be completed at the end of 2016, ITRA model calls for addition of the first new layer to the initial pyramids by the end of 2016.
- 3 New Focus Areas and their Expected National Impact:** The ITRA model is novel, custom-designed to address Indian conditions. The metrics in (2), resulting from two years of defining the model, and then two years of implementing it, reflect its effectiveness, and therefore, the potential benefits of expanding its reach. There are numerous nationally important problem areas (e.g., those overseen by various domain ministries in the government) in which there are well recognized, IT-hungry needs, but expert the ministries/departments may be unable to provide the required IT attention. These may be chosen as new ITRA focus areas in collaboration with the domain ministries. ITRA model could thus be replicated to develop vibrant communities in various areas of national significance, having quality and attributes mentioned earlier. These communities may serve as resources of domain excellence, knowledge exchanges or think tanks. They may already possess answers to unanticipated questions, or may be able to quickly find them.

ITRA's experience in formulating joint initiatives with ICAR and DBT in two focus areas has shown that intra-government collaboration can devise potent joint roadmaps. We have also discovered widespread appreciation of the value IT brings (and much enthusiasm for IT-in-X collaboration with ITRA/Deity) in several Ministries/Depts., e.g., Water Resources, ISRO, Power, HRD, Petroleum & Gas, Defense, Health, Railways, Textiles, and National Disaster Management Authority. However, administrative mechanisms need to be developed to realize the vast potential of such collaborative activities.

An example of the exponential growth for the case of 5 focus areas and an average of 2.5 PINs per LIN (i.e., PIN count is either 2 or 3) is shown in Fig. As another estimate, if 20 focus areas were to be implemented (say, realistically, one per quarter), then based on the results of the two focus areas to date, the 20 areas will yield an estimated minimum of:

- i. 600 active research groups/institutions
- ii. 1000 active researchers
- iii. 1500 PhDs
- iv. 150 technology transfer/start-up plans

4 Exploration of Ways of Achieving (1-3): Towards (1), meetings with team continue to be conducted and teams are developing business plans for possible startups. Towards (2), themes to be pursued by the deepened pyramids in continuation of the current objectives and activities of *ITRA-Mobile* and *ITRA-Water* are being identified. Towards 3, new focus areas that were already approved by ITRA Advisory Council, or those that have resulted from interest expressed by various stakeholders, are being explored. Discussions are ongoing and there is much alignment of such views with, e.g., Ministries of Water Resources, ISRO, Power, HRD, Petroleum & Gas, Defense, Health, Railways, Textiles, and National Disaster Management Authority. Towards this, we propose that ITRA becomes an IT based accelerator, available to all core ministries and departments. The ministries, etc. will then be able to bring advantages of the ITRA model to their domains, and on demand harness the power of IT to enhance their own productivity. Suitable cost sharing and other funding models could be devised. That will also help achieve the long-term sustainability envisaged by the original ITRA model/DPR.



5 Expected National Impact of Many Collaborative Focus Areas between DeitY and other Ministries

We may expect that the types of robust solutions being seen in the two focus areas to date will extend to the domains of many other societally important sectors.

- i. These solutions would help ITRA/DeitY make a widely felt, national impact.
- ii. As the applications broaden, the quality of individual solutions and DeitY’s domain knowledge base would grow steadily, and making the next quantum of impact would become easier.
- iii. Simultaneously, domain ministries would find better solutions to problems in their sectors.
- iv. Since startups are designed to target important problems, they would be well aligned with Hon’ble PM’s *Digital India, Startup-India-Standup-India, Make-in-India* and *Skill-India* initiatives.

The final result will thus be a win-win for ITRA/DeitY, collaborating ministries, and the nation.

Annexures on the following pages present details of the various items discussed on the preceding pages

Annexures

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. Joint Secretary, Higher Education, MHRD
4. Prof. R K Shevgaonkar, Director, IIT Delhi
5. Prof Rajeev Sangal, IIT(BHU) Varanasi
6. MD & CEO, MLAsia
7. President, Nasscom
8. Group Coordinator, Handling ITRA at DeitY
9. Director, ITRA (Member Secretary)

Terms of Reference 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

ITRA-Advisory Council

Composition of ITRA-AC:

1. Prof. S. V. Raghavan, IIT Madras and ex-Scientific Secretary, Office of the 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, IIIT Delhi
15. Prof. Rajeev Sangal, Director IIT(BHU) Varanasi
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
6. Dr. Milind Kulkarni, Scientist G, DST
7. Ms. Rama Vedashree, Vice President NASSCOM
8. Rep NRI Community
9. Rep MLAsia (to be nominated by MD/CEO MLAsia)
10. Finance Officer-ITRA/MLAsia
11. ITRA Officer

Terms of Reference 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 especially 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.

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

S.No.	Name	Designation	% of time devoted to this project	Date of Joining	Date of Leaving
1	Prof. Narendra Ahuja	Director, ITRA	100%	02/06/2011	
2	Dr. Arun Pande	Sr. Level Consultant-ITRA	50%	01/02/2014	
3	Dr. A. Bandyopadhyay	Sr. Consultant	50%	05/01/2015	
4	Dr. Siddhartha Kundu	Sr. Consultant	50%	19/01/2016	
5	Mr. Roop Kishan Dave	Head, Government Initiatives	100%	10/03/2015	
6	Mr. Gaurav Sharma*	Sr. Research Scientist	100%	22/12/2010	
7	Ms. Sonal Sinha	Principle Scientific Officer	100%	10/09/2015	
8	Mr. Mohd. Rizwan Ansari	Senior Scientific Officer	100%	15/09/2015	
9	Mr. Ishant Kumar Bajpai	Scientific Officer	100%	16/09/2015	
10	Mr. Rishabh Gupta	Jr. Network Administrator	100%	21/09/2015	
11	Mr. Avinash	Jr. Web Developer	100%	05/10/2015	
12	Mr. Mohd. Frahim	Jr. Accounts Officer	100%	10/09/2015	
13	Ms. Hina Kundaliya	Executive Assistant	100%	15/12/2014	
14	Mr. Ajay Thomas Cheruthon	Executive Assistant	100%	07/01/2015	
15	Mr. Lalit Mohan Singh	Assistant – ITRA	100%	01/04/2013	
16	Dr. U.P. Phadke	Member, PSIG-ITRA	100%	27/04/2011	09/09/2011
17	Dr. Akshai Runchal	Programme Advisor – ITRA	50%	01/02/2015	24/12/2015
18	Dr. P.K. Reddy	Sr. Level Consultant-ITRA	50%	11/11/2013	30/11/2015
19	Dr. Rajeev Shorey	Sr. Level Consultant-ITRA	50%	01/11/2013	31/10/2014
20	Dr. Umesh Chandra Pandey	Co-ordinator (Technical)-ITRA	100%	04/04/2012	31/03/2013
21	Mr. R.G.S Asthana	Consultant	100%	4/6/2012	31/08/2012
22	Mr. Ashok Kumar Katta	Executive Secretary to Director, ITRA	100%	23/09/2013	31/03/2014
23	Ms. Namrata Nagar	Executive Secretary to Director, ITRA	100%	12/05/2014	28/07/2015
24	Mr. Tushar Sharma	Web Developer	100%	25/09/2014	04/12/2014
25	Mr. Aakash Sharma	Web Developer	100%	10/10/2013	15/09/2014
26	Ms. Himani Sharan	Executive Assistant	100%	15/12/2014	29/05/2015
27	Mr. Sanat Kumar Patra	Management Trainee	100%	05/08/2013	08/01/2015

- On loan from Media Lab Asia

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** has 2 levels – Exemplary and Outstanding, and is 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 selections 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 is 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 GRANTS

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 Grants

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.

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 Grants

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 Grants**

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 Grants**

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 for Evaluation of Student/ Team Performance

1. Research and Development
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
2. Impact on Curriculum
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)
3. Societal Sensitivity Development
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

4. Outreach
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.

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.

A. 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.

B. 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

C. 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.

INTERNATIONAL MENTORS FOR ITRA-WATER AND ITRA-MOBILE PROJECTS

S.No.	Name of the Mentor	Affiliation	ITRA-Institutions associated with	Focus Area
1.	Prof. Praveen Kumar	Univ. of Illinois at Urbana Champaign, IL, USA	1. IIT, Bombay 2. IIT, Hyderabad	<i>ITRA-Water</i>
2.	Dr. Dev Niyogi	Purdue Univ., Indiana, IN, USA	1. IIT, Bombay 2. IIT, Hyderabad 3. IISc Bangalore 4. BITS Pilani, Hyderabad	<i>ITRA-Water</i>
3.	Prof. Binayak P. Mohanty	Texas A&M Univ., College Station, TX, USA	1. IIT, BBSR 2. IIT, Kharagpur 3. IISc Bangalore 4. BITS Pilani, Hyderabad	<i>ITRA-Water</i>
4.	Prof. V. Sridhar	Virginia Tech, Roanoke, VA, USA	1. IIT, Kharagpur 2. IIT, Gandhinagar	<i>ITRA-Water</i>
5.	Prof. James Phillip King	Mexico State Univ., Las Cruces, USA	1. IIT, Bombay 2. IIT, Hyderabad	<i>ITRA-Water</i>
6.	Prof. Adit Singh	Auburn Univ., Auburn, AL, USA	1. Univ. of Hyderabad 2. IIT, Hyderabad 3. IIT Delhi 4. IIIT Delhi	<i>ITRA-Mobile and ITRA-Water</i>
7.	Prof. Sajal K Das	Missouri University of Science and Technology	1. I.I.T. Kharagpur 2. I.I.M. Calcutta 3. N.I.T. Durgapur 4. Jadavpur University 5. University of Calcutta 6. Amrita Vishwa Vidyapeetham, Kerala	<i>ITRA-Mobile</i>
8.	Prof. Sukumar Ghosh	Univ. of Iowa, Iowa City, IA, USA	1. I.I.T. Kharagpur 2. I.I.M. Calcutta 3. Jadavpur University 4. University of Calcutta	<i>ITRA-Mobile</i>
9.	Prof. K. K. Ramakrishnan	Univ. of California, Riverside, CA, USA	1. IIT, Bombay 2. PEC University of Technology, Chandigarh 3. IIT, Madras	<i>ITRA-Mobile</i>

10.	Prof. Supratik Mukhopadhyay	Louisiana State Univ., LA, USA	1. Jadavpur University 2. University of Calcutta 3. NIT, Durgapur	<i>ITRA-Mobile</i>
11.	Prof. Prashant Pillai	Univ. of Bradford, UK	1. IIT, Madras 2. Inst. of Mathematical Sciences, Chennai 3. I.I.T. Kharagpur 4. I.I.M. Calcutta	<i>ITRA-Mobile</i>
12.	Prof. Archan Misra	Singapore Management Univ., Singapore	1. IIIT Hyderabad 2. I.I.T. Kharagpur 3. I.I.M. Calcutta	<i>ITRA-Mobile</i>
13.	Prof. Nitin Vaidya	Univ. of Illinois, Urbana, IL, USA	1. HIT, Delhi 2. Amrita Vishwa Vidyapeetham, Kerala 3. IIT, Delhi 4. Institute of Radio Physics & Electronics, Kolkata	<i>ITRA-Mobile</i>
14.	Prof. Sumit Roy	Univ. of Washington, Seattle, USA	1. IIIT, Delhi 2. IIT, Delhi 3. Amrita Vishwa Vidyapeetham, Kerala	<i>ITRA-Mobile</i>

INTERACTIONS OF TEAMS WITH ADJUNCT FACULTY

Adjunct Faculties (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.

Modes of Interaction

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

A. 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.

B. 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 ITRA-MOBILE PROJECTS

Start date of Project: Jan 1, 2014

Duration: 3 Years

S.No.	Name of the Project
1.	HumanSense: Towards Context Aware Sensing, Inference and Actuation for Applications in Energy and Healthcare
2.	DISARM: Post-Disaster Situation Analysis and Resource Management Using Delay-Tolerant Peer-to-Peer Wireless Networks
3.	Remote Health: A Framework for Healthcare Services using Mobile and Sensor-Cloud Technologies
4.	CARTS: Communication Assisted Road Transportation Systems
5.	Virtual Assistant for mobile devices using voice and gesture technologies for mobile devices using voice and gesture technologies
6.	De-congesting India's transportation networks using mobile devices
7.	Mobile Broadband Service Support over Cognitive Radio Networks
8.	MICRONet : Mobile Infrastructure for Coastal Region Offshore Communications & Networks
9.	Uncoordinated, Secure and Energy Aware Access in Distributed Wireless Networks

Summary of the Quantitative Measures of the Progress Achieved by Nine Mobile Teams

Area	Year 1
2. Research and Development	
# of Publications in Peer Reviewed Conferences included in the ITRA List or of the same Calibre	180
# of Publications in Major Peer Reviewed Journals included in the ITRA List or of the same Calibre	42
# of Peer Reviewed Conferences in which Project Personnel are Organizers (e.g., as Chairs, Reviewers, Committee Members, ..)	104
# 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,)	43
# of invited talks given at major institutions, conferences	61
# of PhD students in the project	76
# of Masters students	72
# of Undergrad students	46
# of students supported to travel to conferences	31
# of Post-Docs	2
# 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	7
2. Impact on Curriculum	
# of New Courses/Modules developed	26
# of New Labs	8
# of Courses/Modules updated in a major way	7
# of Labs Updated in a major way	14
# of New Textbooks authored	5
# of Other Institutions inside/outside the team impacted by the above	7
3. Combined Outreach and Societal Sensitivity Development	
# of Summer/Winter Schools and # of Participants	22 & 800
# of other Short/Long Courses at Conferences, etc., and # of Participants	19 & 300
# of Tutorials at Conferences, etc., and # of Participants	3
# of Distance Education Courses and # of Participants	4
# of Seminars Series and # of Participants	3 & 50
# of Seminars and # of Participants	12
# 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	52

engineering	
# of Contests held for solving various outreach and societal sensitivity challenges organized by NGO and other organizations from time to time	3
# of Other Institutions in/outside the team impacted by the above	1
# of Major Collaborations with Industry. Describe such collaborations and progress made	11
# of Major Collaborations with Government. Describe such collaborations and progress made	9
# of Major Collaborations with NGOs. Describe such collaborations and progress made.	3
# of Major Collaborations with Any Others. Describe such collaborations and progress made	7
# of Technologies/Solutions/Services/Consultations offered to Industry/Government/NGOs/Others	1
# of Industrial Board Memberships/Licenses/Start-ups	7

List of projects in ITRA-Mobile

1. HumanSense: Towards Context Aware Sensing, Inference and Actuation for Applications in Energy and Healthcare

Team Institutions:

1. IIT, Delhi – Lead Institution
2. Shiv Nadar University (SNU), Gautam Budh Nagar
3. Indira Gandhi Delhi Technical University For Women (IGDTUW), Delhi

Lead PI: Dr. Pushpendra Singh; IIT, Delhi

Objectives: 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.

Outlay: Rs. 266.50 Lakhs for 3 years

Sample Outputs and Outcomes:

1. Affordable preventative health-care sensors developed. Eg: Preliminary transducer units for ECG, PPG and SpO₂ are ready.
2. Wearable and smart phone based food intake monitoring mechanism developed:
 - a. Developed smart watch application to collect sensor data.
 - b. Designed an offline, person specific drinking detection model
 - c. Collected drinking activity data from 3 users.
 - d. Currently working on designing person independent model.
3. Detection and localization of parking and un-parking events in indoor parking lots. US Patent filed.
4. Computer Assisted Telephone Survey System: Development and Deployment of a Cloud Telephony platform for remote health care data collection, The system is used by JJ Hospital Mumbai and NIMHANS Bangalore.

Team Size: 43 members including 9 Ph.D. Students 12 faculty members, 17 other students, 4 Mentors (1 National and 3 International) and 01 collaborator.

Progress Metrics:

1. Research and Development

The team has published 14 papers, 10 papers in peer reviewed conferences and 4 papers in peer reviewed journals.

2. Curricular Impact

- a. 6 weeks summer training program on “Mobile Architecture and Programming by using J2ME (Asha OS), Nokia X (Android), Python & Linux (Raspberry Pi)” was conducted during 16th June 2014 to 25th July 2014, 41 participants.
- b. Courses on Wireless Sensor Networks (at SNU), Design & development of Smart Phone Internet of Things (at IGDTUW), Data Provenance (at IIT-Delhi) were updated.
- c. IOT Lab (at SNU) and Computer Architecture Lab (at IGDTUW) were developed.

3. Outreach and Societal Sensitivity

A smart watch application to collect sensor data and a preliminary transducer and signal conditioning unit for Lead II ECG and multiple PPG signals is currently under development which may lead to possible TOT/ Commercialization / Startup.

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

Team Institutions:

1. IIT, Kharagpur – Lead Institution
2. IIM, Kolkata
3. Indian Institute of Engineering Science and Technology, Shibpur
4. NIT, Durgapur
5. Kalyani Government Engineering College, Kalyani
6. Heritage Institute of Technology, Kolkata

Lead 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. 427.58 Lakhs for 3 years

Sample Outputs and Outcomes:

1. Designed density based clustering algorithms for Outdoor Landmark identification from vehicular traces.
2. Designed Energy-efficient outdoor navigation using smart phone sensors (inertial).
3. Designing a simulator to observe how crowd-sensing helps to dynamically re-generate traffic maps in disaster scenario.
4. Currently designing an android application for gathering crowd-sourced route data without using GPS.
5. Android application for collecting Typing activity and predicted emotion using ML techniques developed.
6. A DTN-based P2P sync tool for post-disaster applications called pSync developed
7. A novel generalized energy-efficient outdoor localization application (UrbanEye) scheme designed.
8. A situational analysis tool for situational information aggregation, filtering and integration during propagation through our tiered architecture, which may also be used for distributed query processing at different tiers of control.

Team Size: 92 members including 14 Ph.D. Students, 15 faculty members, 57 other students, 4 Mentors (1 National and 3 International) and 2 collaborator.

Progress Metrics:

1. Research and Development

The team has published 47 papers, 37 papers in peer reviewed conferences and 10 paper in peer reviewed journals.

2. Curricular Impact

- a. 6 summer/ winter school courses were organized as well as 4 short courses.
- b. New courses on Smartphone Computing and Applications, Social Networks, Performance Modeling of Computer Networks, Ubiquitous Computing, Creating and Managing ICT-Based Innovative Startup with a focus on Social Entrepreneur Development, Complex Networks, Mobile Computing.
- c. A Video Lecture series on Short term course on Recent Trends in Opportunistic and Social Networks and its applications was introduced in KGEC Kalyani.
- d. A lab was developed on Systems and Mobile Research Lab.

3. Outreach and Societal Sensitivity

Post-disaster Services using Rapidly Deployed Devices to Establish Communication in (Disruption-Prone) Networks, Density based Clustering Algorithms for Outdoor Landmark Identification from Vehicular Traces and an Android application for collecting typing activity and predicted emotion using ML techniques were designed and are currently under development which may lead to possible TOT/ Commercialization / Startup.

4. Media Attention

- a. IBM Faculty Award (Animesh Mukherjee).
- b. Best Paper Award, ICDCN (Sandip Chakraborty).
- c. INAE Best Doctoral Thesis Award (Sandip Chakraborty).

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

Team Institutions:

1. Jadavpur University, Kolkata – Lead Institution
2. University of Calcutta, Kolkata
3. Indian Institute of Engineering Science and Technology, Shibpur
4. Kalinga Institute of Industrial Technology, Bhubaneswar
5. Feroze Gandhi Institute of Engineering and Technology, RaeBareli
6. NIT, Durgapur

Lead 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.: 525.49 lakhs for 3 years

Sample Outputs and Outcomes:

1. Developed JSON based on SaaS applications for ontology driven data model suitable for cloud based NoSql or Sql databases.
2. An android app has been developed and tested with test data consisting of JSON tree.
3. An Architecture of sensor-cloud has been proposed in which virtual sensors are defined at the IaaS and PaaS levels.
4. A generic interface has been created for allocating, de-allocating and managing virtual sensors at IaaS level.
5. A sensor-cloud infrastructure has been implemented for management of sensors as remote resources.
6. A theoretical model of Resource Instance and Resource Request has been developed.
7. The concepts of virtual sensors have been developed and different types of virtual sensors have been defined.
8. Few preliminary APIs have been implemented and their performances have been observed.
9. A greedy algorithm for resource Brokering in Sensor-Cloud Architecture has been proposed
10. Developed an Ontology Driven conceptual data Model suitable for cloud environment with the support for conceptualization of heterogeneous data types ranging from structured to semi-structured and schema based to schema less.

Team Size: 52 members including 18 Ph.D. Students, 9 faculty members, 19 other students, 3 Mentors (1 National and 3 International) and 3 collaborators.

Progress Metrics:

1. **Research and Development**
 - a. 44 papers have been published in reputed journals/conferences.
 - b. 5 patents have been granted to the team.
2. **Curricular Impact**
 - a. 2 course have been added / updated in the curriculum in the institution of team.
 - b. 7 workshops/ summer school have been conducted by the team. 4 seminars were organized by the institutions of the team.
 - c. The sensor Network Laboratory and the Cloud Computing facilities at School of Mobile Computing and Communication in Jadavpur University have been updated in a major way.
 - d. Prof. Nandini Mukherjee, JU, Kolkata and Prof. Sarmistha Neogy, JU, Kolkata under project Remote-Health co-authored a book entitled “Building Wireless Sensor Networks: Theoretical and Practical Perspectives” published by CRC Press.
 - e. Prof. Jaya Sil, IEST shibpur under project Remote-Health authored a Book Chapter on: Feature Selection for Adaptive Decision Making in Big Data Analytics in book Data Science and Big Data Computing - Frameworks and Methodologies, Springer.
3. **Outreach and Societal Sensitivity**

The Remote Health team has set up Remote Health Kiosks in Bengal. The team has also designed and implemented a patient data collection service with a bilingual interface as well as a prescription generation service are currently under development which may lead to possible TOT/ Commercialization / Startup.
4. **Media Attention:**
 - a. “Best Outreach Program Award” in January 2015 (Received media attention for the outreach program.
 - b. Winner of IOT League and Best University Demo Award in COMSNETS 2016.

4.CARTS: Communication Assisted Road Transportation Systems

Team Institutions:

1. IIT, Bombay - Lead Institution
2. PEC University of Technology, Chandigarh
3. University Institute of Engineering and Technology, Panjab University

Lead PI: Dr Bhaskaran Raman, IIT Bombay

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. 109.39 Lakhs for 3 years

Sample Outputs and Outcomes:

1. Completed design of Content-Centric Networking (CCN) framework.
2. Developed models for real time road condition detection. Events that can be detected are: Left turn, right turn, normal brake, sudden brake, sudden forward acceleration, bump, pothole, rough road. Driving behaviour has been characterized to accuracy rate of 89% (approx) for turns and 97% (approx) for braking and sudden acceleration. Road conditions detected at accuracy: 90% (approx) for bump and potholes.
3. Developed mechanisms for detecting Bus Boarding Event using smartphone sensors.
4. Developed mechanisms for finding occupancy in bus using crowdsourced data from smartphones.
5. Developed algorithms for GSM based positioning for public transportation commuters.
6. Developed algorithms for efficient and accurate localization of cell-phones using crowdsourced data.
7. Developed automated and unsupervised methods for determining bump (Pothole, and braking) detection on roads using smartphone sensors such as accelerometers, magnetometers, GPS. Currently working towards development of a comprehensive App.
8. Working on developing models for prediction of arrival time of public transportation systems using smartphones based crowdsourcing data.
9. Working on usage of Barometer for traffic congestion detection.

Team Size: 30 members including 6 Ph.D. Students, 8 faculty members, 15 other students, 2 Mentors (1 National and 1 International) and 5 collaborators.

Progress Metrics:

1. Research and Development

The team published 5 papers in peer reviewed conferences.

2. Curricular Impact

- a. 1 short course and an open house session was organized by the team.
- b. 1 new course has been added to the curriculum.

3. Outreach and Societal Sensitivity

A smartphone based system for real time bus information, accident detection, and accident forensics is currently under development which may lead to possible TOT/ Commercialization / Startup.

5. De-congesting India's Transportation Networks Using Mobile Devices

Team Institutions:

1. IIT, Madras - Lead Institution
2. Institute of Mathematical Sciences, Chennai
3. Dept. of Physics, University of Calcutta, Kolkata
4. NIT Tiruchirappalli
5. IIM, Bangalore

Lead PI: Dr Krishna Jagannathan, IIT Madras

Objectives: 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.

Outlay: Rs. 243.12 Lakhs for 3 years

Sample Outputs and Outcomes:

1. Developed an intricate understanding of stability of car following models with delayed feedback.
2. Analyzed bifurcation phenomena that establish the emergence of limit cycles – oscillations which may explain the emergence of phantom jams.
3. Derived conditions for non-oscillatory convergence.
4. Developed methodology to approximately derive the marginal and total cost of traffic congestion in Delhi, using publicly available data.
5. Developing a distributed route learning framework based on a bandit problem with shared samples through a social network.
6. Derived centrality properties, and node degree distributions for the bus network in Chennai.
7. Analyzed contagion evolution on Chennai bus network.
8. Developing a network control and optimization framework.
9. Development of a distributed system to automatically schedule movements of the vehicles in such a way that no collision occurs, and no vehicle is ever required to deviate from its pre-specified route.

Team Size: 14 members including 3 Ph.D. Students, 6 faculty members, 3 other students, 2 Mentors (1 National and 1 International)

Progress Metrics:

1. Research and Development

The team has published 7 papers, 6 papers in peer reviewed conferences and 1 paper in peer reviewed journals.

- a. **Curricular Impact:**-2 summer/ winter school courses were organized as well as 2 short courses.
 - b. 1 new course has been introduced to the existing curriculum.
 - c. 1 textbook has been authored by the faculty in the team.
2. **Outreach and Societal Sensitivity:**-An intricate understanding of stability of car following models with delayed feedback as well as a methodology to approximately derive the marginal and total cost of traffic congestion in Delhi, using publicly available data. It is currently under development which may lead to possible TOT/ Commercialization / Startup.

6.Virtual Assistant for Mobile Devices using Voice and Gesture Technologies

Team Institutions:

1. IIIT, Hyderabad - Lead Institution
2. VNR Vignana Jyothi Institute of Engineering & Technology, Hyderabad
3. Padmashri Dr. B. V. Raju Institute of Technology, Vishnupur

Lead PI: Dr. Manish Srivastava, 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. 155.90 Lakhs for 3 years

Sample Outputs and Outcomes:

1. Acquired real data sets to facilitate building of virtual assistants for healthcare domain.
2. Developed prototype virtual assistant in (for Health Advisory, Stress Analysis, Cough Analysis) multimodal mode for healthcare domain.
3. Developed a mobile application, which can be executed on any Android device to classify cough signals either as Wet cough signal or Dry Cough signal. The application takes the cough signal as input and classifies as wet or dry.
4. Collected medical textual data for 185 diseases and their symptoms. Converted this data to a decision tree for user Health Advisory system.
5. Around 20 hours of high quality dialog data collected from a doctor's clinic in Hyderabad city. The data collected with the help of the physician using Zoom/Edirol recorders. Each recording consists of the conversation between a doctor and a patient, leading to a diagnosis by the doctor.
6. 60 sec voice recordings in different languages were collected from people of different age groups varying from 30-65 years suffering from high blood pressure and also low blood pressure. The voice recordings from the normal people were also collected and stress was analyzed.
7. Collected 100+ cough samples of normal people and those who are suffering from Tuberculosis and Asthma from two hospitals in Hyderabad city with the help of a physician using Easy voice recorder mobile application and cough samples were analyzed.
8. Recording of multimodal audio-video data in using a kiosk like architecture.

Team Size: 15 members including 2 Ph.D. Students, 4 faculty members, 4 other students, 2 Mentors (1 National and 1 International) and 3 collaborators.

Progress Metrics:

1. Research and Development

14 papers have been published in reputed journals/conferences.

2. Curricular Impact

- a. Two new courses have been added in the institution of the team.
- b. One Summer School and One Workshop have been conducted by the team.
- c. Courses introduced on Natural Language Processing and Speech Technology.
- d. Course on Information Retrieval updated.

3. Outreach and Societal Sensitivity

- a. A prototype virtual assistant for the healthcare domain has been developed.
- b. The team has also developed a decision tree for user health Advisory system from collected medical textual data for 185 diseases and their symptoms and an Android mobile application which can classify cough signals either as Wet cough signal or Dry Cough signal.
- c. The cough analyzers are currently under development which may lead to possible TOT/ Commercialization / Startup.

7. Mobile Broadband Service Support over Cognitive Radio Networks

Team Institutions:

1. IIT Delhi, New Delhi - Lead Institution
2. LN Mittal Institute of Information Technology, Jaipur
3. Institute of Radiophysics and Electronics, Calcutta University, Kolkata
4. North Eastern Regional Institute of Science & Technology, Itanagar
5. NIIT University, Neemrana

Lead 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. 487.91 Lakhs for 3 years

Sample Outputs and Outcomes:

1. A new framework for energy harvesting cognitive radio network developed, performance analyzed.
2. Performance of multi-hop cognitive relay networks with clusters of relays analyzed.
3. Bio inspired optimization based algorithm for dynamic threshold in energy based spectrum sensing is developed.
4. Remote generation of microwave/MM wave signal for mobile broadband has been done.
5. Single on-chip FPGA implementation of GA and evolutionary optimization based spectrum sensing algorithm development have been done.

Team Size: Total size of the team is 32 which include 17 Ph.D. Students 5 faculty members, 3 other students, 5 Mentors (2 National and 3 International) and 2 collaborators.

Progress Metrics:

1. Research and Development

45 papers have been published in journals/ conferences of repute.

2. Curricular Impact

- a. 3 courses have been added in the curriculum in the institution of the team.
- b. 3 seminars have been organized by the team.
- c. A book on cognitive radio has been prepared and it's under review.
- d. Course modules on advanced communication with introduction to cognitive radio for M.Tech (at IRPE Kolkata), Cognitive Radio (at LNMNIIT Jaipur), Software Defined Radio (at NIITU) were introduced.
- e. A new lab on communication and cognitive radio (at IRPE) and a wireless lab for SDR / CR activities has been set up.
- f. LTE simulation module for QualNet simulation platform and Computer Architecture Lab (at LNMIIT).

8.Micronet - Mobile Infrastructure for Coastal Region Offshore Communications & Networks

Team Institutions:

1. Amrita Vishwa Vidyapeetham, Coimbatore - Lead Institution
2. Indian Institute of Space Science and Technology, Thiruvananthapuram
3. Indian Institute of Information Technology and Management-Kerala, Thiruvananthapuram

Lead 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. 232.17 Lakhs for 3 years

Sample Outputs and Outcomes:

1. Developed an adaptive, demand driven and energy efficiency algorithm for provisioning of the back-haul network.
2. Application-driven Design of OpenFlow Wireless Mesh Network for FisherMesh 2.0 has been developed.
3. Designed and implemented an optimization scheme for backhaul utilization.
4. New class of Directional and Omni-directional antennas designed, fabricated and tested indigenously.
5. Created a novel Software-defined wireless mesh network architecture based on OpenFlow.
6. Proposed and prototyped controller-switch handoff mechanism.
7. An Ensemble-based decision tree classification algorithm for finding the best signal strength node developed.
8. Mobility prediction algorithm for finding missing boats developed.
9. Design and development of Pentagonal Patch single antenna & antenna array -gain enhancement& range measurement (simulation + experimental studies) has been done.

Team Size: Total size of the team is 68 which include 8 Ph.D. Students 7 faculty members, 43 other students, 6 Mentors (2 National and 4 International) and 4 collaborators.

Progress Metrics:

1. **Research and Development**
 - a. 35 papers have been published in journals/ conferences of repute.
 - b. 1 Patent has been filed.
2. **Curricular Impact**
 - a. 9 courses have been added in the curriculum and three specializations have been incorporated in the M. Tech program.
 - b. Workshops and Sea trials have been conducted with the help of fisherman. Four seminars have been organized by the team.
 - c. Antenna Design, Advanced Signal Processing, Distributed Systems and Mobile Computing courses introduced.
 - d. Amrita University added modules on Small Cell Network in Mobile Communication course and Cognitive Radio in Advanced Wireless Course.
3. **Outreach and Societal Sensitivity**
 - a. Mobile Infrastructure for Fishing Boats off the Coast of Kerala has been developed.
 - b. A directional antenna for low power communication from offshore boats is currently under development which may lead to possible TOT/ Commercialization / Startup.
 - c. A real time information service to guide offshore fishing and disseminate offshore information to boats is currently under development which may lead to possible TOT/ Commercialization / Startup.
 - d. A system to establish communication among off-shore fishing boats and with shore is currently under development which may lead to possible TOT/ Commercialization / Startup.

9.Uncoordinated, Secure and Energy Aware Access in Distributed Wireless Networks

Team Institutions:

1. Indian Institute of Technology (IITB), Bombay - Lead Institution
2. Tata Institute of Fundamental Research (TIFR), Bombay
3. National Institute of Technology (NITK), Surathkal, Karnataka
4. National Institute of Technology (NITD), Durgapur

Lead 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 for 3 Years.

LIST OF *ITRA-WATER* PROJECTS

Start date of Project: Jan 1, 2014

Duration: 3 Years

S. No.	Name of the Project
1.	GridSense (Groundwater-Irrigation-Disease Sensing System) : ICT in Water and Pest/Disease Management for Yield Improvement in Horticulture (Citrus)
2.	Improving Groundwater Levels and Quality through Enhanced Water Use Efficiency in Eastern Indian Agriculture
3.	Measurement to Management (M2M): Improved Water Use Efficiency and Agricultural Productivity through Experimental Sensor Network
4.	Integrated Urban Flood Management in India: Technology-Driven Solutions
5.	AquaSense : Development of Effective Wireless Sensor Network System for Water Quality and Quantity Monitoring

Summary of the Quantitative Measures of the Progress Achieved by Five Water Teams

Area	Year 1
2. Research and Development	
# of Publications in Peer Reviewed Conferences included in the ITRA List or of the same Calibre	38
# of Publications in Major Peer Reviewed Journals included in the ITRA List or of the same Calibre	32
# of Peer Reviewed Conferences in which Project Personnel are Organizers (e.g., as Chairs, Reviewers, Committee Members, ...)	49
# 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,)	42
# of invited talks given at major institutions, conferences	46
# of PhD students in the project	30
# of Masters students	26
# of Undergrad students	32
# of students supported to travel to conferences	6
# of Post-Docs	1
# of Tools/Technologies developed	10
# of Technical contests held for solving various technical/other field-relevant challenges organized by professional societies and other organizations from time to time	19
2. Impact on Curriculum	
# of New Courses/Modules developed	15
# of New Labs	12
# of Courses/Modules updated in a major way	5
# of Labs Updated in a major way	10
# of New Textbooks authored	8
# of Other Institutions inside/outside the team impacted by the above	4

3. Combined Outreach and Societal Sensitivity Development	
# of Summer/Winter Schools and # of Participants	9 & 175
# of other Short/Long Courses at Conferences, etc., and # of Participants	10 & 150
# of Tutorials at Conferences, etc., and # of Participants	2 & 80
# of Distance Education Courses and # of Participants	0
# of Seminars Series and # of Participants	7 & 60
# of Seminars and # of Participants	9 & 460
# 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	8
# of Contests held for solving various outreach and societal sensitivity challenges organized by NGO and other organizations from time to time	2
# of Other Institutions in/outside the team impacted by the above	6
# of Major Collaborations with Industry. Describe such collaborations and progress made	7
# 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	32

List of projects in ITRA-Water

1. GridSense: ICT in Water and Pest/Disease Management for Yield Improvement in Horticulture (Citrus)

Team Institutions:

1. Indian Institute of Technology Bombay, Mumbai- Lead Institute
2. Indian Institute of Technology, Hyderabad
3. Dr. Panajbrao Deshmukh Krishi Vidyapeeth, Akola
4. Govt. College of Engineering, Amravati
5. Shri Shivaji College of Horticulture, Amravati

Lead PI: Prof. J. Adinarayana, IIT Bombay

Objectives: 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.

Outlay: Rs. 331.82 lakhs for 3 years

Sample Outputs and Outcomes:

1. Developed a Lasso Regularization based regression model using remote sensing and watershed parameters for predicting Gummosis disease severity.
2. Developed optimal irrigation schedules which improves water use efficiency and helps to mitigate the disease attack.
3. Developed new/improved version of SenseTube: wireless sensing and analysis platform
4. Developed Aquifer Map of the study area using Hydro-Geo Analyst and GIS.
5. Developed a protocol for performing 3-D ERT and 3-D time-lapse ERT
6. Developed Stage-I Model for gummosis disease prediction and disease rating and study of its correlation with environmental factors is in progress.
7. Developed Aquifer Map of the study area (from ERT experimentation done in the 1st year) using Hydro-Geo Analysis and GIS
8. Designed optimal irrigation schedule to improve water use efficiency and to mitigate the disease attacks.
9. Deployed low-cost low-power soil moisture sensor network on selected fields to study the moisture patterns.
10. Configuration of Remote Sensing (RS) and proximal sensing system based Stage II model for irrigation scheduling under progress.

Team Size: 32 members including 4 Ph.D. Students, 6 faculty members, 11 other students, 5 Mentors (3 national and 2 International) and 06 collaborators.

Progress Metrics:

1. Research & Development:

- a. Team has filed 2 Patent applications.
- b. Team has published 18 papers in various Peer Reviewed Conferences/Journals and has participated in 16 invited talks at major conferences.

2. Curricular Impact:

- a. A Rural Informatics Lab (at CSRE, IITB) was introduced.
- b. Application module for Interoperability Course; Remote Sensing of Vegetation; and Sensor Network and its application in Natural Resources (at IITB) were updated.
- c. Hydrology and Groundwater Lab (at IITH), Mycology and Plant pathology Lab (at PDKV), Agro-Informatics Lab (at CSRE, IITB), Hydro-geology and Groundwater Lab (at CSRE, IITB), and Development of Molecular and Biochemistry Lab with an addition of – 80 Celcius deep freezer (at Yavatmal Dr.PDKV, Akola) were updated.
- d. Prof. M.S.Dudhare, Prof. R.M.Gade and Prof. R.G.Dani co-authored a book entitled “Biosafety in Plant Biotechnology”, New chapters on Hydro-geologic characterization and Geophysical Inversion and Additional modules at graduate level course in “Groundwater Modeling” (CE 6530) (at IIIT H), and a book chapter (Groundwater Management using GIS Tools) in Edited Book: Four Decades of Groundwater Research (CRC Press) was released during 6th IGC Conference, 2015 were authored by the team members.

3. Outreach & Societal Sensitivity:

- a. 1 Winter/Summer School, 3 Short/Long Courses at Conferences with approx. 90 participants and 2 Seminars with approx. 130 participants, were organized by the team.
- b. “A wireless platform to sense and manage crop resources”, “A service for identifying, delineating, managing and developing ground water resources in hard rock aquifers of India” and “A soil-testing system” is currently under development which may lead to possible TOT/ Commercialization / Startup.

2.Improving Groundwater Levels and Quality through Enhanced Water Use Efficiency in Eastern Indian Agriculture

Team Institutions:

1. Indian Institute Of Technology, Bhubaneswar - Lead Institution
2. Indian Institute Of Technology, Khargpur
3. Kalinga Institute of Industrial Technology University, Bhubaneswar
4. College of Agriculture Engineering and Technology, Odisha University of Agriculture and Technology, Bhubaneswar

Lead PI: Prof. R. K. Panda, IIT Bhubaneswar

Objectives: (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 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. 371.72 lakhs for 3 years

Sample Outputs and Outcomes:

1. Groundwater potential zones were mapped using remote sensing, GIS and multi-criteria decision analysis techniques based on analysis of geological, geomorphological, land use/ land cover information and water table fluctuations at 46 locations.
2. Spatio-temporal variation of groundwater recharge was computed through the Hydrologic Evaluation of Landfill Performance (HELP3) model.
3. The daily root-zone soil moisture is estimated using one-dimensional (1-D) physically-based model, Soil Water Atmosphere Plant (SWAP) in open-loop controller using meteorological data, MODIS Leaf area index (LAI) product (MOD15A2), soil water retention and hydraulic conductivity parameters
4. The SMOS satellite surface soil moisture has been downscaled at 1-km spatial resolution using MODIS daily Land Surface Temperature (Terra/MOD11A1 and Aqua/MYD11A1) and 16-day NDVI product MOD13A2 for estimation of finer scale root zone soil moisture.
5. Recharge estimation by water level fluctuation methods and different empirical methods has been completed.
6. Grid-based soil moisture and hydraulic properties data at 0.5, 3 and 9 km are monitored periodically using theta probes.
7. Water and Nitrogen balance studies to estimate the nitrogen production function of crops in eastern India (rice, okra and green gram) is being carried on. Physical and chemical analysis of the soil at the experimental sites has been done.
8. The Vertical Electrical Sounding (VES) tests have been completed for basin demarcation at 38 locations.
9. Digital map of study watersheds have been prepared using Arc GIS 10.1.
10. The relationships between bulk density and textural class, SOM & OC under different plantations have been established
11. Baseline surveys for profiling demography, land use pattern, irrigation courses, etc. are being carried in 156 sample villages and 39500 households.

Team Size: 24 members including 4 Ph.D. Students, 8 faculty members, 3 other students, 2 Mentors (1 National and 1 International) and 07 collaborators.

Progress Metrics:

1. Research & Development:

- a. Team has published 9 papers in various Peer Reviewed Conferences/Journals and has participated in 9 invited talks at major conferences.

2. Curricular Impact:

- a. Field Lysimetric laboratory setup, automatic weather station, 4 test beds with data loggers, soil moisture monitoring system, ground water level monitoring system, Establishment of continuous automatic water level recording systems for runoff water measurement under different plantations, and Establishment of subsurface drip irrigation system for execution of project work and demonstration to UG and PG laboratory classes were introduced.
- b. Existing Water Quality Laboratory was updated.
- c. Prof. B. Behera, Prof. H. K. Sahoo, Prof. S. N. Dash, Prof. N.Sahoo and Prof. S. Mohanty (2015) co-authored a book chapter on Sustainable rural livelihood security in rainfed rice farms through on-farm water harvesting structures,chapter-26, Managing natural resources in the dry lands – constraints and opportunities, for Satish serial publishing house, New Delhi.

3. Outreach & Societal Sensitivity:

- a. 3 Open Houses were organized by the team.
- b. “A service to optimally locate water recharge sites and tube wells” is currently under development which may lead to possible TOT/ Commercialization / Startup.

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

Team Institutions:

1. Indian Institute of Technology, Kharagpur (IITKGP)- Lead Institute
2. Indian Institute of Technology, Gandhinagar (IITGN)
3. Indira Gandhi Krishi Vishwavidyalaya, Raipur (IGKV)
4. College of Agricultural Engineering and Technology, AAU, Godhra (CAET,AAU)
5. North Eastern Regional Institute of Science and Technology, Itanagar (NERIST)

Lead 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. 563.24 lakhs for 3 years

Sample Outputs and Outcomes:

1. Developed “Drought Monitoring System” and “Statistical Model to predict Vegetation Anomaly”.
2. Sensitivity analysis was completed for development of Hydrologic Modeling Framework. Now, the Model is being modified to consider rice field hydrology.
3. SWAT Model setup is completed for Kangsabati River Basin.
4. Identified and prioritized critical sub-watersheds and Hydrologic Response Units (HRUs) on the basis of estimated runoff, sediment yield and nutrient losses using ArcSWAT.
5. Developed server-side utilities for blind identification of sensor and nodes in absence of node identifiers; and identification of faculty data. The team has also developed and deployed SMS based control and status check of sensor nodes and weather station, including upload interval, node faults, soil parameters, etc.
6. Automated link error detection system has been incorporated into the cloud, which classifies the incoming readings to the server into error and error-free classes.
7. Characterization of various basin parameters using hydrological, geomorphological, soil resources and satellite data in the environment of GIS is in progress.
8. Water management studies undertaken on Maize (*Zea mays L.*) and Finger Millet (*Eleusine Coracana*) in midland situation of Chhattisgarh Plains
9. Analyzed infiltration characteristics, advance and recession curve under prevalent irrigation practices and analysis on effect of micro-climate in the command area of sub-minors due to long application of canal water in these fields.
10. Weather station was installed at West Bengal site and the weather information is being monitored in real time.

Team Size: 31 members including 9 Ph.D. Students, 11 faculty members, 3 other students, 2 Mentors (1 National and 1 International) and 04 collaborators.

Progress Metrics:

1. **Research & Development:**
 - a. Team has filed 3 Patent applications.
 - b. Team has published 31 papers in various Peer Reviewed Conferences/Journals and has participated in 5 invited talks at major conferences.
2. **Curricular Impact:**
 - a. Soil and Water Engineering lab (at IGKV), Non-Point Source lab (at IIT Kgp) and Water Quality and Remote Sensing labs (at IIT Ggn) were introduced. A course on “Prototype water ponding sensor” (at IIT Kgp) was also updated.
 - b. Geoinformatics lab (at IGKV), and Experimental Sensor Network set up (at IIT Kgp and IIT Ggn) was updated.
 - c. Prof. Tripathi, M.P., Agrawal, N., Tiwari, P., and Bisen, Y. (2014). “Watershed Modelling and Management Using SWAT.” Technical Bulletin, IGKV/Pub./T.Bl./2014/10; Tripathi, M.P., Nigam, G.K., Khalkho, D. and Tiwari P. (2014). “Hydrological Measuring Instrument” Practical Manual, IGKV/Pub./P/Mi./2014/08, Vimal Mishra and Reepal Shah (2015). Climate Change in Madhya Pradesh: Indicators and Impacts (report submitted to the state government of MP), and Amit Garg, Vimal Mishra, and Hem Dholakiya (2015). Climate Change and India: Adaptation Gap (2015) (report submitted to the Ministry of Environment and Forest (MoEF) were some of the Monographs authored by the team members.
3. **Outreach & Societal Sensitivity:**
 - a. 3 Winter/Summer School, 4 Short/Long Courses at Conferences and 3 Seminars with approx. 330 participants, have been organized by the team.
 - b. “A service to predict rainfall over a 7-30 day period and advise selection of crops to be planted” is under development which may lead to possible TOT/ Commercialization / Startup.

4.Integrated Urban Flood Management in India: Technology-Driven Solutions

Team Institutions:

1. Indian Institute of Science, Bangalore - Lead Institution
2. Centre for Development of Advanced Computing, Trivandrum
3. Birla Institute of Technology and Science Pilani –Hyderabad Campus, Hyderabad
4. National Institute of Technology, Warangal

Lead 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. 344.78 lakhs for 3 years

Sample Outputs and Outcomes:

1. Development of IDF relationships and time series analysis
2. Sensor Network Based Cyber Physical Infrastructure for Continuous Monitoring of Water Distribution Networks is built in the IISc laboratory to study the flow behavior as well as the quality degradation in the water network.
3. Developed urbanization model for the Hyderabad city using Landsat satellite images
4. LiDAR survey was conducted in the campus.
5. Multi objective Genetic Algorithm (MOGA) based methodology has been developed to model non-linear trend in the extreme rainfall series in the absence of physical covariates.
6. Developed a comprehensive GIS including all relevant spatial and temporal components of the study area is developed.
7. The storm water drainage network is modeled in SWMM software for various inflow conditions to analyze the flooding scenario in the study area. A software package inp.PINS is used as a tool to interface between GIS and SWMM model.
8. Development of 2D overland flow model and its integration with GIS is in progress.
9. Prototype of Rainfall sensor has been completed and development is in progress.
10. PCB fabrication for Data Logger development is completed and the prototype under testing.

Team Size: 22 members including 6 Ph.D. Students, 6 faculty members, 3 other students, 1 Mentor (International) and 6 collaborators.

Progress Metrics:

1. Research & Development:

- a. Team has published 8 papers in various Peer Reviewed Conferences/Journals and has participated in 11 invited talks at major conferences.

2. Curricular Impact:

- a. Urban Hydrology Course has been approved by the senate and will be offered in first semester of 2016-2017. Topic covered in this course are: SWMM, HEC-HMS, HEC-RAS, EPANET, WEAP, SWAT;MAP WINDOW, urban flood forecasting and mitigation strategies; Urban flood planning in changing climate; description of general circulation models and downscaling approaches (at IISc)
- b. Module for urban storm water modeling using SWMM has been included in Hydraulic and Hydrologic Design Lab course of M.Tech, Water Resources Engineering Programing (at NITW).
- c. Labs on Scaled model of open channel (at IISc), and Sensor Network Based Cyber Physical Infrastructure for Continuous Monitoring of Water Distribution Networks (at IISc) have been developed for studying the flow behavior as well as the quality degradation in the water network

3. Outreach & Societal Sensitivity:

- a. 5 Winter/Summer School, 3 Short/Long Courses at Conferences with approx. 60 participants, have been organized by the team.
- b. “A service to design water drainage networks, and to forecast, analyse the effect of, and manage urban floods” is currently under development which may lead to possible TOT/ Commercialization / Startup.

5. Development of effective Wireless Sensor Network system for water Quality and Quantity Monitoring (AquaSense)

Team Institutions:

1. University of Hyderabad, Hyderabad - Lead Institute
2. International Institute of Information Technology, Hyderabad
3. Vallurupalli Nageswara Rao Vignana Jyothi Institute of Engineering and Technology, Hyderabad
4. Sambalpur University Institute of Information Technology, Sambalpur, Orissa
5. Sree Chaitanya College of Engineering, Karimnagar, AP
6. Sree Chaitanya Institute of Technological Sciences, Karimnagar, AP

Lead 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. 350.79 lakhs for 3 years

Sample Outputs and Outcomes:

1. Developed "Flow measuring unit, self-power generating unit for the smart flow meter and different communication modules, like (RF module, GSM module)" and testing is in progress.
2. Developed Wireless Sensor Nodes for Over Head Tanks and water pipe line with real time data logging to the server and this data to be monitored remotely through website.
3. Developed software model to measure the water quantity and in the process of developing algorithm for detecting leakage in supply pipe
4. Developed a model using Advection-diffusion Equation for River Mahanadi. It is implemented using MATLAB and validated with secondary Data.
5. Developed a machine learning algorithm for alert finger print capture and classification. The model was tested with both real data and synthetic data.
6. Developed an algorithm for optimal deployment of sensor using heuristic method in order to determine optimal localization of sensors in various test areas depending on the geometry of the coverage area of water body. Database schema was developed for storing the data
7. Developed Android App for informing/ Sending images of water leakages/ Complaints of water leakages in the pipe lines to the sever by the general public. Two students involved in developing this application has started a start-up company at Indore, Madhya Pradesh for general purpose complain reprisal system for the local body.
8. Developed a Prototype for water body profiling (width and depth measurement along with location and time stamp).
9. Developed a PHP based server for receiving/collecting data but presently migrating to JAVA based server application for better data management and display.

Team Size: 38 members including 7 Ph.D. Students, 8 faculty members, 16 other students, 2 Mentors (1 National and 1 International) and 05 collaborators.

Progress Metrics:

1. **Research & Development:**
 - a. Team has filed 2 Patent applications.
 - b. Team has published 4 papers in various Peer Reviewed Conferences/Journals and has participated in 5 invited talks at major conferences.
2. **Curricular Impact:**
 - a. A course module on Wireless Sensor Network, Pollution Modeling in Environment Sciences (at SUIIT), and new module was introduced in the WSN course 2 were updated.
 - b. AquaSense Lab, Fluid Mechanics Lab, and Communication were updated.
3. **Outreach & Societal Sensitivity:**
 - a. 4 Seminars has been organized by the team
 - b. "A system for sensing and wirelessly disseminating consumer water quality information" and "A service to provide infrastructure support for setting up a water sensor network in a given region" is currently under development which may lead to possible TOT/ Commercialization / Startup.

Annexure 9

Institutions involved in various ITRA Projects

Sr. No	Inst. Name ▼ Projects ►	ITRA- MOBILE PROJECTS									ITRA- WATER PROJECTS					No. of Research Groups
		M1	M2	M3	M4	M5	M6	M7	M8	M9	W1	W 2	W 3	W 4	W 5	
1	IIT BHUBNESWAR											L				1
2	IIT BOMBAY					L				L	L					3
3	IIT CHENNAI				L											1
4	IIT DELHI							L								1
5	IIT GANDHINAGAR												L			1
6	IIT HYDERABAD										P					1
7	IIT KHARAGPUR		L									P		L		3
8	IISc BANGALORE												L			1
9	IIST TRIVANDRUM								P							1
10	IMSC CHENNAI				P											1
11	IIM BANGALORE				P											1
12	IIM KOLKATA		L													1
13	TIFR MUMBAI									P						1
14	IIIT DELHI	L														1
15	IIIT HYDERABAD						L							L		2
16	IIITM KERALA								P							1
17	NIT DURGAPUR		P	P						P						3
18	NIT SURATKAL									P						1

	of IT, ORISSA																	
37	IG KRISHI VISHWAVIDYALAYA, RAIPUR														P			1
38	SS COLLEGE OF HORTICULTURE, AMARAWATI													P				1
39	UIET, CHANDIGARH					P												1
40	AMRITA KOLLAM								L									1
41	LNMIIT JAIPUR								P									1
42	NIIT UNIVERSITY NEEMRANA								P									1
43	SNU NOIDA	P																1
44	BITS PILANI, HYDERABAD													P				1
45	BVRIT NARSAPUR						P											1
46	HIT KOLKATA		P															1
47	KIIT BHUBNESWAR			P										P				2
48	SREE CHAITANYA CE, KARIMNAGAR																P	1
49	SREE CHAITANYA IT, KARIMNAGAR																P	1
50	VNRVJIET HYDERABAD						P										P	2
	No. Research Groups in the Project	3	6	6	5	3	3	5	3	4		5	4	4	5	6		62

Legend:

Abbreviation	Meaning
M1	<i>ITRA-Mobile Project - HUMANSENSE: Towards Context Aware Sensing, Inference And Actuation For Applications In Energy And Healthcare.</i>
M2	<i>ITRA-Mobile Project - DISARM: Post Disaster Situation Analysis And Resource Management</i>
M3	<i>ITRA-Mobile Project - REMOTE HEALTH: A Framework For Healthcare Services Using Mobile And Sensor Cloud Technologies</i>
M4	<i>ITRA-Mobile Project - DECONGESTING: De-Congesting India's Transportation Networks</i>
M5	<i>ITRA-Mobile Project - CARTS: Communication Assisted Road Transportation Systems</i>
M6	<i>ITRA-Mobile Project - VIRTUAL ASSISTANT For Mobile Devices Using Voice And Gesture Technologies</i>
M7	<i>ITRA-Mobile Project - COGNITIVE RADIO: Mobile Broadband Service Support Over Cognitive Radio</i>
M8	<i>ITRA-Mobile Project - MICRONet: Mobile Infrastructure For Coastal Region Offshore Communications & Networks</i>
M9	<i>ITRA-Mobile Project - UNCOORDINATED: Uncoordinated Secure Energy Aware Access In Distributed Wireless Networks</i>
W1	<i>ITRA-Water Project - GRIDSENSE: Groundwater Irrigation Disease Sensing System</i>
W2	<i>ITRA-Water Project - IGWL: Improving Groundwater Levels & Quality And Quality Through Enhanced Water Use Efficiency In Eastern Indian Agriculture</i>
W3	<i>ITRA-Water Project - URBANFLOOD: Integrated Urban Flood Management In India: Technology Driven Solutions</i>
W4	<i>ITRA-Water Project - MEASUREMENT TO MANAGEMENT: Improved Water Use Efficiency And Agricultural Productivity Through Experimental Sensor Network</i>
W5	<i>ITRA-Water Project - AQUASENSE: Development Of Effective Wireless Sensor Network System For Water Quality And Quantity Monitoring</i>
L	LEAD INSTITUTION
P	PARTNER INSTITUTION