

## **WS1.1 :: Subimal Ghosh**

### **Statistical downscaling to assess impacts of climate change on Indian rainfall**

General Circulation Models (GCMs) are the climate models, which simulate large scale climate variables globally considering green house gas emissions and projects for next century. However, GCM simulations are not reliable for local scale projections and they fail to simulate rainfall, which is a major input for hydrology. Downscaling refers to the projections of local scale hydrological variables from large scale GCM simulated climate variables. Empirical downscaling models based on statistical relationships are known as statistical downscaling. This talk demonstrates the applications of statistical downscaling models for subdivisional as well as river basin scale hydrologic projections. Uncertainties resulting from multiple models are further taken care using reliability ensemble averaging. Scopes for using the downscaled projections in impacts and adaptation studies will also be discussed.

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## **WS1.2 :: Ana Deletic**

### **Water sensitive cities in developing countries**

Designing our settlements for resilience to the impacts of climate change, particularly ensuring secure water supplies and the protection of water environments, is an emerging challenge as growing urban communities seek to minimise their impact on already stressed water resources. In Australia the concept of Water Sensitive Cities (WSC) has been recently developed as the answer to these challenges. Three key principles set the foundation for a Water Sensitive City:

1. Cities as Water Supply Catchments: meaning access to water through a diversity of sources at a diversity of supply scales

2. Cities Providing Ecosystem Services: meaning the built environment functions to supplement and support the function of the natural environment
3. Cities Comprising Water Sensitive Communities: meaning socio-political capital for sustainability exists and citizens' decision-making and behaviour are water sensitive.

The talk will address a possibility of adopting the Water Sensitive Cities concept in developing countries. In particular it will discuss a hypothesis that developing countries have more of a chance of 'leapfrogging' to Water Sensitive Cities future than developed countries because they are less 'locked' into past large scale water infrastructure investments and inflexible institutional arrangements.

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### **WS1.3 :: Terence Chan**

#### **Decision support tools for integrated water resource management**

The complexity of water resource systems (i.e. catchments), with multiple stressors and relationships, and associated high uncertainty, makes decision-making for management a challenge. This seminar will explore some of the research that the Monash Sustainability Institute and the Water Studies Centre have undertaken to develop tools to assist in management decision-making for water resources. In particular, we discuss the use of interdisciplinary research and risk assessment. We also introduce Bayesian network model development, demonstrate how such a tool may be used interactively to explore the relative benefits of alternative management actions, and finally, examine how this fits into an adaptive management framework.

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### **WS2.1 :: Paul McShane**

#### **Developing Integrated catchment management strategies for sustainable water use in response to Climate Change**

India shares with other countries in the region the twin challenges of addressing climate change and poverty alleviation. Climate change threatens changes to major catchments measurable as increased frequency of droughts and floods disproportionately impacting on the rural poor. We present an integrated management framework for sustainable water use in response to climate change using the Mahanadi basin as a case study. Linking climate science to hydrology for improved forecasts of environmental, social and economic impacts, our study aims to provide a framework for proactive response to

climate change through practical and cost effective policy development and application. A Bayesian network approach provides for an integrated model and allows for inclusion of information on environmental, social and economic impacts given likely scenarios of climate change. We link this to Knowledge Management to encourage a collaborative approach among agencies to adapt to climate change. This approach provides a synoptic framework accessible to policy makers and exemplifies an integrated examination of likely consequences for catchment-dependent communities.

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## **WS2.2 :: H S Shankar**

### **Studies in small scale on site waste water purification for local reuse**

Waste water purification for reuse is well known in Australia ; it is relatively new in India. In India existing technologies for waste water & sewage treatment apply to very large scales , suffer from process failures , consume much energy leading very high costs of treatment .

Towns and cities in India do not yet have underground sewerage . Such pipelines involve much capital expenses. However if waste water can be treated to river water quality in small scales then the same be deployed for local reuse ; else could be discharged via existing storm water drains at practically very low costs so ensure that such storm water drainages are kept in good shape through the year. Engineered natural systems come with no moving parts , consume very little energy , very low operating costs and very green features so seem more appropriate in the local context.

IITB has developed such a green technology called SBT and CAMUS SBT and established a number small scale working plants whose economic , ecological , space footprint features seem very useful to urban and semi-urban communities. IIT B has also set out an arrangement for commercial use of the technology through SINE ( Society for Innovation & Entrepreneurship) IITB.

Both SBT and CSBT use a media , culture and additives to bring about removal of COD, BOD, ammonia, nitrate and phosphates. Investigations show that the chemistry at work can be adequately described by the following 5 reactions: i) nitrite reduction to ammonia say X1 , ii) nitrite oxidation to nitrate say X2, iii) nitrite & ammonium reaction to form nitrogen gas and water say X3, iv) cell mass synthesis , say X4, v) aerobic

respiration, say  $X_5$ . Here  $X_1$  to  $X_5$  refer to rates ( kg/cum. hr) of these reactions. Experiments and field investigations show that

$$X_5/X_4 = 2 (X_3/X_1) (C/N)/\alpha.$$

Where  $C/N$  refer carbon to nitrogen ratio in feed and  $\alpha$  is g. biomass / g. N in biomass. The above result provides a way of design, operation, automation and control of the purification process. This feature is engaged in the water purification activities implemented thus far.

The presentation will cover field experience in the design, operation and commercialization of the technology.

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### **WS2.3 :: K Narayanan**

#### **Socio-economic context of Vulnerability and Adaptation**

It is well established that Climate change poses serious threats and challenges to both developed and developing economies. Climate change interacts with many other types of changes. Vulnerability to climate change is unique, and calls for separate analysis. Impacts of Climate Change are global, intertemporal and highly inequitable and, poor regardless of country to suffer the most. Climate change imposes significant stress on resources as well. With respect to India, two observations have been made: the severity of droughts and intensity of floods in various parts of India might increase, and most of the river basins in India may experience constant water scarcity and shortage and are likely to experience seasonal or regular water stressed conditions. The predicted increase in frequent and intensive floods and droughts are likely to have unfavorable impacts on the occupational structure, food security, health, social infrastructure etc. of the hotspots. Identifying livelihoods likely to be affected by climate related uncertainties: rainfall, temperature, sea level changes, extreme events etc is the need of the hour. It is also important to study the uncertainties exacerbated by system inefficiencies (social, economic, political), and the policies and institutions, market, government, physical infrastructure, social infrastructure, and demographic factors (population growth, density, literacy) in the context of Climate Change. We need to document the existing and potential mechanisms of adaptation, and identify the possible incentives to adapt to the impacts of climate change.

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## **WS2.4 :: N C Narayanan**

### **Trans-disciplinary water research with societal relevance: Concept, strategy and practice**

The presentation at the outset explains the concept and need for transdisciplinary research on issues of direct societal relevance in the water sector. It also reviews the experience of developing an interdisciplinary academic programme (“Crossing Boundaries” Programme) in Integrated Water Resources Management linking four South Asian engineering universities and the Wageningen University, Netherlands. The new challenges in water governance with the increasing demands, ecological dimension of resource depletion, conflicts between users, fragmented governance structure etc are issues beyond the conventional training of engineers. Along with sound domain knowledge, the water professionals need skills and attitudes to address challenges such as: (a) incorporating ecological concerns; (b) comprehending both technological and social systems; (c) constructive involvement of various interest groups in decision-making etc. The ‘Crossing Boundaries’ programme and some other academic endeavours in CTARA, IIT Bombay attempts to integrate this skill-building into the current teaching and research programmes.

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## **WS2.5 :: Milind Sohoni**

### **Challenges in rural drinking water**

We will start the basic governance structure for rural drinking water provision and its technical backbone. We will then outline our research on this subject and the nature of new problems arising out of climate change, over-exploitation of groundwater and other reasons. We will then focus on a few concrete areas of current interest, viz., modelling, planning support tools and the design of village drinking water schemes. The talk stresses on the inter-disciplinarity of the problem.

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## **WS3.1 :: Suparna Mukherjee**

### **Water disinfection with chloridized silver surfaces**

Inactivation of microorganisms is of utmost importance in ensuring a clean and safe supply of potable water. There is a growing interest in the use and development of silver based disinfection technologies owing to its safe and effective bactericidal action. The present work aims at studying the bactericidal effect of silver in a batch reactor equipped with chloridized silver wires. Chloridization of silver wires was achieved either chemically (using NaOCl) or electrochemically (using KCl). Chloridization resulted in deposition of a coating of AgCl on the silver wires. The disinfection effect of chloridized wires was compared to that of uncoated wires. The disinfection kinetics and time required for disinfection was studied using three strains of bacteria, i.e., Escherichia coli MTCC 443, Bacillus subtilis MTCC 441 and E. coli MTCC 739. Change in disinfection kinetics with changes in water quality was also studied. Batch reactor studies for bactericidal kinetics performed at both high (10<sup>9</sup> CFU/mL) and low (10<sup>3</sup> CFU/mL) initial cell concentration demonstrated that chloridized silver wires could achieve much larger reduction in bacterial cell count compared to uncoated silver wires. The time for complete disinfection was least in nutrient broth, intermediate in deionised water and highest in tap water. Initial cell concentration (N<sub>0</sub>) had a significant influence on the time required for disinfection. While for initial cell concentration of 10<sup>3</sup> CFU/mL complete disinfection could be achieved within 20 minutes, initial cell concentration of 10<sup>9</sup> CFU/mL required about 30 hours for strain E. coli MTCC 443 in DI water. Batch reactor studies revealed that both the number and position of chloridized silver wires affected the disinfection kinetics. A natural pond water sample with a heterogeneous microbial consortium could be completely disinfected within 2 hrs.

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## **WS3.2 :: Huanting Wang**

### **Composite membranes for energy-efficient desalination**

Composite membranes have attracted great interest because they have shown improved separation properties. These membranes have been extensively studied for gas separation; recently, the application of composite membranes has been extended from gas separation to water desalination.

We have recently synthesized silicalite-polyamide composite membranes via interfacial polymerization on a commercial polysulfone substrate, for the purpose of studying the effect of the addition of silicalite nanocrystals on the desalination property of polyamide membrane. With increasing loading of silicalite nanocrystals, the water flux of

composite membranes increased while the salt selectivity decreased. Plain polyamide membrane had salt rejection of 98.1% and flux of 1.83 LMH whereas the silicalite-polyamide composite membrane, prepared from TMC-hexane with 0.5% (w/v) silicalite, had water flux of 9.86 LMH and NaCl rejection of 50% at a feed pressure of 34.48 bar by using 2000 ppm salt solution as the feed.

We have also developed a novel carbonaceous poly(furfuryl alcohol) membrane by partially carbonizing a poly(furfuryl alcohol) layer supported on a polysulfone substrate with high-concentration sulfuric acid at room temperature. As compared with the poly(furfuryl alcohol) membrane, the carbonaceous poly(furfuryl alcohol) membrane exhibited significantly enhanced chlorine resistance and water desalination properties. After the chlorine treatment, the carbonaceous poly(furfuryl alcohol) membrane exhibited a salt rejection of 73.7% and a water permeability of 2.20 LMH at a feed pressure of 34.48 bar and using 2000 ppm NaCl solution as the feed, whereas the PFA membrane had a salt rejection of only 60.1% and a water permeability of 0.18 LMH.

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### **WS3.3 :: A. K Suresh**

#### **Structure-property relationships in interfacial polymeric membranes: Applications to RO**

Reverse osmosis (RO) is emerging as a method of choice in winning portable water from saline and brackish waters. There remain problem areas in the technology, many of which have to do with the membrane materials. Thin \_lm composite membranes, which typically contain a thin layer of dense polymer on top of a macroporous polymer support which in turn is supported on a nonwoven polymeric cloth, have emerged as the materials of choice over the years. The selective dense layer is usually made by an inter-facial polycondensation reaction, and polyamides are the most popular. As far as basic performance is concerned, water ux and salt rejection are the indicators one focusses on, and the challenge is to improve the former while not compromising too much on the latter. Clearly, an understanding of how the membrane structure evolves during reaction, and how structure is related to functional properties, are relevant considerations if one wants to take a fundamental approach to the problem. Then there are other issues such as the resistance of the membrane material to bio-fouling and chloride attack. In this talk, we will focus on fundamental kinetic and mechanistic studies on the basic reaction itself, which lead to mathematical models which allow a degree of design capability for the membrane properties. Also in focus will be some recent experimental studies specifically on the polyamide RO membranes, aimed at an identification of the important preparation parameters and material improvements.

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## **WS3.4 :: Gil Garnier**

### **Novel strategies for advanced industrial process water recycling**

In Australia, one of the world's driest industrial countries, advanced and ever increasing levels of industrial process water recycling are mandated by social, economical and environmental requirements. Direct consequences of high industrial water recycling are increases in the process water temperature, ionic strength and concentration of colloids and dissolved solids. These effects have restricted the level of process water recycling by decreasing the efficiency of the polyelectrolytes typically used as process aids and creating many problems such as deposits and corrosion. To address these issues, novel strategies of industrial water recycling have been investigated at APPI/BioPRIA in partnership with paper and chemical industries. These include a combination of novel approaches using traditional technologies: selective coagulation/adsorption, optimization of the flocculation and polymer adsorption time frames- and the development of novel technologies such as salt/temperature sensitive polymers and water Life Cycle Analysis.

In the first part of this presentation, the effects of the polyelectrolyte adsorption kinetics and ionic strength on the dynamics of particle flocculation for precipitated calcium carbonate (PCC) and cationic polyacrylamides (CPAM) at low shear rates are analyzed. In the second, selective removal of color, COD, phosphorus by salt induced process water coagulation and adsorption (lignite, activated carbon) are investigated. Last, a novel strategy relying on the process water's high ionic strength and temperature to trigger polyzwitterion adsorption/ binding is presented.

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## **WS4.1 :: Shresth Tayal**

### **Source Vulnerability Assessment: A cumulative approach of risk quantification for water industries**

Vulnerability is the direct function of susceptibility i.e., probability of occurrence of risks and impacts of those risks on the system, and inverse function of the capabilities to mitigate the risks. The major concerns leading to vulnerability for a water based industry are considered to be the availability of water as well as the quality of water available. However, neighbourhood of the industry including the local community and other water utilities, coupled with laws and regulations prevailing in the area play an important role in sustainable operations of the industry.

An attempt is made to quantify and integrate various vulnerability regulators taking the case study of a beverage plant and its watershed as the neighbourhood. Water quantity was assessed using hydrological modeling tools, water quality using the chemical tests as well as the sources of pollution to the water source; vulnerability due to neighbourhood was assessed using the water requirements along with the perception of the community toward the industry and regulatory vulnerability by assessment of rules and laws prevailing as well as capability of local regulatory authorities to affect the smooth operations. The scores received by the various factors feed into a scale ranging from 1-5, with 5 making the industry concerned as extremely vulnerable and 1 as the least.

The results are being further calibrated by applying the scale to different set of industries located in different types of watersheds, and a fully developed integrated platform will present an effective tool for the water based industries to ensure sustainability of their operations by adopting effective measures in advance.

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## **WS4.2 :: Surendra Kulkarni**

### **Challenges in water: Perspectives from Dow Chemicals**

Constantly changing political, economic, and cultural landscape of the world depends, at least in part, on the critical resources of that time. While a bulk of the wars of the 20th century was fought over oil, and previous ones - probably over land or treasures, it is said that water will be the cause of unrest in the 21st Century. With the ever-growing demand of the expanding civilization (for water), depleting natural resources, and increasing pollution of existing sources, puts enormous pressure on ensuring water security for the future. The quantity and quality of water available for human consumption and industrial use are major problems that need to be tackled sustainably.

At Dow, water has been identified as a "Mega-theme" for the next century and a priority area to focus on. Water finds disproportionate attention in our "2015 Sustainability Goals" for the company. This talk will describe key areas that Dow R&D is focusing on. Separating impurities from water is the main approach. This talk will start off with ion exchange resins from Dow's portfolio (that dominated nearly half a century), describing their capabilities and limitations. Next generation technology involved Reverse Osmosis (RO). Dow is the largest manufacturer of RO membranes, and we will examine the opportunities and capabilities in this area. We will then look at Ultra-filtration and beyond.

Going beyond the current range of products, some directions for research and development in providing innovative solutions to tackle water scarcity will be touched upon.

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### **WS4.3 :: Adil M Dhalla**

#### **Water: Challenges and Opportunities**

The human population has grown more in the last 50 years than it did in the previous 4 million years. We can see this as both a challenge and an opportunity. Renewable resources – power and water, sustain the quality of our life, and are also economically sound. Less than 1% of the world's freshwater is readily available for human use. The amount of water that's safe for us to use is declining sharply due to pollution and contamination. We need water not only to survive, but also to prosper and grow. With water demand tripling by 2030, we have to be three times as smart. Our business, GE Water & Process Technologies brings together experienced professionals and advanced technologies to solve the world's most complex challenges related to water availability and quality, increased productivity and cost reduction, and environmental regulations.

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### **WS4.4 :: Bhanu Neupene**

#### **Role of UNESCO in Climate Change Science, Impacts and Adaptation**

Climate change is an issue that already affects and will increasingly impact all nations. The complexity of the problem is intrinsically linked with overarching societal issues. Progress is required on effective mitigation, adaptation, reduction of greenhouse gas emissions, development of green technologies, and political support for the establishment of effective international and national policies.

UNESCO is working with Member States and communities in addressing the risks that climate change poses to them and their futures through the UNESCO Climate Change Initiative.

The presentation will introduce UNESCO's climate change and water action in India, which currently builds around three strategic objectives:

- Building and maintaining the climate change knowledge base: science, assessment, monitoring and early warning;
  - Promoting mitigation of and adaptation to climate change, including through enhanced education and public awareness; and
  - Moving towards a climate-neutral UNESCO.
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## **WS4.5 :: K.V.Suryam**

### **Challenges of Water Management: An Industry perspective**

Accelerated industrial growth demands huge quantities of water. Industrial growth also puts enormous pressure on existing water bodies and a supply-demand shortfall is always seen in areas where many new industries are taking shape. In recent times, many industries are coming up in barren lands where availability of water in required quantities is a core issue.

Effective water management has become one of the most critical factors in the success and sustainability of “operating-water” intensive industries, such as Power, Steel, Refineries, Paper and Pulp, Food and Beverages. Major challenges lie in effective water management and conservation, extensive recycling and reuse, and above all, innovative ways and means of water treatment that will fully meet the end user requirements with uninterrupted and sustained levels of production. This presentation will elaborate on the challenges that industries in general and RIL in particular are facing.

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## **WS4.6 :: Peter Dillon**

### **Managed Aquifer Recharge: Harnessing Natural Treatment Processes for Water Recycling**

Use of Managed Aquifer Recharge (MAR) has rapidly increased in Australia, USA, and Europe in recent years as an efficient means of recycling stormwater or treated sewage effluent for non-potable and indirect potable reuse in urban and rural areas. Yet aquifers have been relied on knowingly for water storage and unwittingly for water treatment for millennia. However it has taken a significant investment in scientific research in recent years to demonstrate the effectiveness of aquifers as sustainable treatment systems to enable managed aquifer recharge to be recognised alongside engineered treatment systems in water recycling. It is a ‘cross-over’ technology that is applicable to water and wastewater treatment and makes use of passive low energy processes to spectacularly reduce the energy requirements for water supply. It is robust within limits, has low cost, is suitable from village to city scale supplies, and offers as yet almost untapped opportunities for producing safe drinking water supplies where they do not yet exist. It will have an increasingly valued role in securing water supplies to sustain cities affected by climate change and population growth. However it is not a

universal panacea and relies on the presence of suitable aquifers and sources of water together with effective governance to ensure human health and environment protection and water resources planning and management. This paper describes managed aquifer recharge, illustrates its use in Australia, outlining economics, guidelines and policies, and presents some of the knowledge about aquifer treatment processes that are revealing the latent value of aquifers as urban water infrastructure and provide a driver to improving our understanding of urban hydrogeology.

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## **DS1.1 :: F C Kohli**

### **Does the Digital Divide Exist?**

For people to use computers extensively, they should be able to talk to the computers in their own language. Computer's work in India is mainly software and that too for export purpose. This computerization is in English language and does not address computerization in Indian languages. There are 900 million people who do not speak English and they need to converse with computers in their own language. If India wants to overcome the so called digital divide, which is not difficult as we have witnessed the introduction of 600 million mobile phones all over the country.

Information Technology is both Software and Hardware and not Software alone. India's Hardware industry is less than 1% of the World's hardware. However, if the computerization in India takes off in Indian languages, then India would need an input of 25 to 30 million PCs a year rather than 6 million as at present. This will invariably lead to Hardware industry.

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## **DS1.2 :: Ashwin Gumaste**

### **Toward SGrid-less Optics and the Open Lambda Assignment and Routing Problem**

Two innovations that have made possible high-speed networking in the WAN area especially in the metro and core space are WDM and high-speed Ethernet. WDM facilitates good usage of the fiber by dividing the optical spectrum into discrete wavelengths. Gigabit and 10 Gigabit Ethernet on the other hand take the onus of transport away from traditional SONET/SDH technologies making the transport of voluminous data more affordable. These innovations have however outlived their cause, creating a need for newer technological paradigms. Moving away from the classical ITU-

T grid WDM hierarchy we proposed the Reach Optimized Architecture for Multi-rate Transport System (or ROAMTS) that facilitates significantly better fiber utilization while enhancing the reach of very high-speed signals. In fact the ROAMTS framework will be shown in the talk to present the maximum ever fiber utilization. The ROAMTS framework leads to an optimization problem called OLARP (Open lambda Assignment and Routing Problem) that is an extension of the well known RWA problem. The OLARP framework opens a new set of paradigms for WDM networking in the metro, core and long-haul spaces. It further goes on to make the IP over WDM paradigm a reality with tunable optics and MEMS based WSSs.

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### **DS1.3 :: Shonali Krishnaswamy**

#### **Mobile and Ubiquitous data mining**

The growth and proliferation of mobile and embedded devices presents an exciting new opportunity for intelligent data analysis. The range of applications in this domain include: Road Safety, Environment/Habitat Monitoring, Patient Monitoring/Mobile Healthcare, and Real-Time Business Intelligence for the Mobile Workforce etc. This talk will present our innovative contributions in the area of Mobile and Ubiquitous Data Stream Mining and visualisation in terms of developing the first suite of adaptive, resource-aware light-weight data stream analysis algorithms and clutter-adaptive visualisation approaches for mobile devices. The light-weight algorithms autonomously adapt their functioning according to varying computational constraints, data rates and application constraints. The talk will present both the theoretical underpinnings for Mobile Data Stream Mining as well as on-going and completed application case studies which involve the use of these techniques with our collaborators in the space of Mobile Healthcare, Intelligent Transportation Systems and Habitat Monitoring using Wireless Sensor Networks. The talk will also present an overview of the integrated mobile data mining system/toolkit (Open Mobile Miner) that we have developed at our centre.

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### **DS2.1 :: Rushikesh Joshi**

#### **Properties of object oriented design metrics**

Object oriented languages provide a rich set of abstractions for engineering of solutions.

However, the structural quality of a design and hence the corresponding code depend heavily on how the software gets engineered in terms of a set of abstractions and their interconnections. One often encounters software that works but that is hard to understand and to change and evolve. Design metrics can provide some insights into some aspects of design quality or lack of it. However, there are many aspects of design, and they are typically beyond the one number that gets produced by a particular design metric. In this talk, some of our observations resulting from the studies carried out in this area will be presented with a brief discussion on future directions.

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## **DS2.2 :: Chris Ling**

### **Notions of workflow correctness in different contexts (Video)**

The talk introduces notions of correctness in workflow processes which is the speaker's research interest. Henceforth, research projects undertaken by the speaker have been somewhat related to "correctness" issues in workflow processes. The speaker then provides an overview of these research projects – past and present – all involving workflow correctness both directly and indirectly in different contexts and environments.

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## **DS2.3 :: Pushpak Bhattacharyya**

### **Natural language processing, ambiguity and word sense disambiguation**

There are no two words in recognizing the fact that Natural Language Processing (NLP) - the field dealing with machine understanding and generation of natural language- is one of the key components in dealing with digital divide. The world is multilingual and so is the web these days. Multilinguality and ambiguity are the key challenges facing NLP today.

Word Sense Disambiguation (WSD) has been looked upon as the holy grail of NLP. Since 70s investigations have been going on the computational techniques of word sense disambiguation. Prior to that, of course, traditional scholarship has pondered on the question of correct determination of the meaning of a word. In this presentation we will give a brief survey of computational approaches of word sense disambiguation. Then we will take up the question of WSD in the context of Indian languages where the challenge is lack of resources in terms of rich machine readable dictionaries, wordnets, sense marked corpora and so on. Our long standing work on Indian language wordnets and

WSD has shown that it is possible to make use of the resources created for one language for the task of WSD of another language. We conclude by pointing a way toward creating a large framework for multilingual, multi domain WSD for Indian languages.

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## **DS2.4 :: Mark Carman**

### **Hierarchical and tripartite topic models for routing queries, personalizing retrieval and predicting ratings.**

In this talk I discuss our ongoing investigations in applying topic modeling to problems in information retrieval. Topic models are generative latent-variable models that can deal with sparsity in high dimensional data through dimensionality reduction. I will discuss a hierarchical topic model that can be used to route queries to vertical search engines. I will also describe "tripartite" models for personalizing retrieval based on information in a query click-through log or in social bookmark data. Finally I will discuss a model for item recommendation based on user-ratings data.

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## **DS2.4 :: Ganesh Ramakrishnan**

### **Feature Induction in Machine Learning- Exploring the Search space Efficiently and Effectively**

It has repeatedly been found that very good predictive models can result from using Boolean features constructed by an Inductive Logic Programming (ILP) system with access to relevant relational information. The process of feature construction by an ILP system, sometimes called "propositionalization", has been largely done either as a pre-processing step (in which a large set of possibly useful features are constructed first, and then a predictive model is constructed) or by tightly coupling feature construction and model construction (in which a predictive model is constructed with each new feature, and only those that result in a significant improvement in performance are retained). These represent two extremes, similar in spirit to filter and wrapper based approaches to feature selection. An interesting, third perspective on the problem arises by taking search-based view of feature construction. In this, we conceptually view the task as searching through subsets of all possible features that can be constructed by the ILP system.

For the case of features that are simply conjunctions of basic propositions, we present

some of our recent results on optimal and efficient construction of a small set of simple conjunction features.

For the more general case of features in the language of horn clauses in first order logic, an exhaustive search of such a space will usually be intractable. We resort instead to a randomised local search which repeatedly constructs randomly (but non-uniformly) a subset of features and then performs a greedy local search starting from this subset. The number of possible features usually prohibits an enumeration of all local moves. Consequently, the next move in the search-space is guided by the errors made by the model constructed using the current set of features. This can be seen as sampling non-uniformly from the set of all possible local moves, with a view of selecting only those capable of improving performance. The result is a procedure in which a feature subset is initially generated in the pre-processing style, but further alterations are guided actively by actual model predictions. We test this procedure on language processing task of word-sense disambiguation. Good models have previously been obtained for this task using an SVM in conjunction with ILP features constructed in the pre-processing style. Our results show an improvement on these previous results: predictive accuracies are usually higher, and substantially fewer features are needed.

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## **DS3.1 :: N L Sarda**

### **Ontology based flexible querying system**

Ontology captures concepts and their relationships in a specific domain, such as agriculture, health-care or education. Ontology is accepted as a way of providing semantics to data stored in databases as well as data or text present in documents. In today's information-rich world, data exists in both structured and non-structured format, and it is important to relate these two types of data for meeting information needs of users. A data-centric and structure centric approach taken by query languages (typically used in application development, such as SQL for relational databases) assume that the user knows both the structure and the contents as well as their inter-relationships and that the user knows exactly what is required by him. This may not be a case in rural context or in cases where the user is seeking advice based on some known facts and observations. A flexible querying system proposed here is driven by ontologies, and can use the context as well as knowledge to automatically expand the query and orient the response that enables action or better understanding of

alternatives. We will outline our goals for such a flexible query system, present its architecture, and motivate it for use in some advisory services in rural sectors.

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## **DS3.2 :: Yung- Fang**

### **Unlocking research knowledge – An ontology driven approach**

Data-intensive disciplines are producing large quantities of raw data. These data are often managed in an ad-hoc manner, hampering wider sharing, dissemination and systematic reuse. The large volumes of data and the fact that the logic models of data evolve over time contribute to making data management an increasingly challenging task. In this talk I'll present an ontology-centric approach to data management, where the behaviours of domain concepts and objects are captured entirely by ontological entities, around which all data management tasks are carried out. The open and semantic nature of ontology languages makes this approach extensible, domain-independent and amenable to greater data reuse and integration.

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## **DS3.3 :: Umesh Bellur**

### **Research challenges in cloud computing**

While there has been a tremendous amount of hype over cloud computing over the last few years, it's not been clear as to what the challenges for researchers are in this space. At first glance cloud computing appears to be nothing more than grid computing in a new avatar (with the focus on scheduling) – however a closer look reveals issues that are not immediately apparent. It turns out that the basis of cloud computing is actually virtualization and with this understanding comes a host of issues related to virtualization that have not been looked at earlier. A few of them include the P2V problem that revolves around determining the capacity of the virtual machine to be deployed given the application behavior on a physical machine, the Server consolidation problem that looks at techniques to pack virtual machines as tightly as possible, the load balancing problem that looks at VM migration costs as one of the factors in balancing load and others. In this talk, I will explore some of these issues and look at possible approaches to solve them.

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## **DS3.4 :: Bala Srinivasan**

### **Sensing for a better life**

The last decade has witnessed the rapid advancement in cellular/wireless communication technologies. Now it is feasible that sensors deployed in environments or attached to the devices can send their sensed data wirelessly to remote systems or can share with other sensors for cooperative learning and for decision making. Intelligence can also be built-in to these observations which once again can be communicated to individuals and communities for their betterment. Such an infusion of these technologies can change the way we live on this earth. IBM has coined the term “Smarter Planet” for such exploitation of the technology. In this talk, we start with few examples where such a technology works for common person and describe a one shot learning algorithm both for the memorisation and recall of patterns from the data collected from large WSN for pattern identification.

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## **DS3.5 :: Nandita Bhattacharjee**

### **Authentication, Identification and Secure Communication through Biometrics**

The most emerging technology for people authentication and identification is biometrics. In contrast with traditional approaches, biometric authentication relies on who a person is or what a person does, being based on strictly personal traits, much more difficult to be forgotten, lost, stolen, copied or forged as compared to traditional techniques. In this talk, we focus on two vulnerable points of biometric systems: privacy concerns due to storage of biometric templates in a database and biometrics cannot be exactly reproduced due to variations during biometric data acquisition or verification. Specifically we propose a method based on error correcting codes to secure the stored templates and the use of fuzzy extractor which is error tolerant thereby creating a reliable biometric cryptosystem for secure communication.

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## **DS4.1 :: Subhasis Chaudhuri**

### **Bridging the divide: Extending the outreach of distance education**

How can we increase the through-put of an education system and to enhance its outreach - possibly by using distance education? We shall discuss development of technologies for distance education, so that its outreach could be extended through a drastic reduction of data even to mobile platforms, enabling a student to study on the move. The key idea a programmed playback of the key frames from the video along with the audio, according to a metadata derived from the original video. We shall also demonstrate how to affect a legibility retentive display of instructional media on miniature display devices. Details of the technology developed at IIT Bombay will be explained during the talk.

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## **DS4.2 :: Kavi Arya**

### **E-Yantra : Empowering Engineering College students through Robotics**

We give a brief overview of challenges faced in designing and building embedded systems today and the role of Model Based Design in the process. We give an example of one such model-based design language, Esterel, a language used as the basis for building many safety critical systems. We also talk about project E-Yantra, centered around our lab in IIT-Bombay which seeks to popularize the study of embedded systems and robotics through low-cost educational robot designed at IIT-Bombay. The E-Yantra project motivates students to learn more about embedded systems and model-based design through hands-on experimentation.

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## **DS4.3 :: Kannan Moudgalya**

### **Spoken tutorial for IT literacy and employment**

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## **DS4.4 :: Iqbal Gondal**

### **Remote Equipment Health Monitoring**

MACHINE health monitoring (MHM) is crucial in all industrial processes to achieve high reliability, reduced man power and condition based maintenance. It specifically deals with abnormality detection and diagnosis. In case of rotary machinery, malfunctioning in

the operation of the bearing is the most common fault. The bearing faults generate certain vibration patterns. These patterns change according to the variations in the machine dynamics depending upon the type of the fault and therefore, vibration data captured from machine can be analysed to detect the type of the faults. The MHM system can be modelled into four steps: Data acquisition unit for capturing the vibration data, preliminary processing involves the extraction of time-frequency information from the signal, feature selection and fault diagnosis. This talk will present the framework for remote machine health monitoring, which can be applied to different sectors of the industry to monitor the real time industrial processes.

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#### **DS4.5 :: Larry Stillman**

##### **The Digital Doorway: Social-Technical Innovation for High-Need Communities**

The application of the Living Lab (LL) approach to social-technical innovation to the Digital Doorway Initiative by the Meraka Institute of the South African Council for Scientific & Industrial Research (CSIR) is outlined in the context of the initiative's evolution from an educational project focussed on a public access computer to a broader community innovation initiative in partnership with Monash University in South Africa and Australia. The project approach is also relevant to the development of Digital Doorway initiatives in Australia with Indigenous Communities. The Digital Doorway was originally inspired by the 'Hole in the Wall' project of Sugata Mitra in Delhi.

The relationship between different stakeholders is explored as a future research and practice challenge for both the study of ICTs for development, and the fostering of community-driven social-technical innovation. The activity also offers a research challenge for understanding the cultural transformations that are necessary for bringing about more effective integration between technical and social-technical viewpoints about design and research in a social context.

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#### **DS4.6 :: Maria Indrawan**

##### **Scientific Data Management in E-Science (video)**

This talk will focus on the general issues of E-Science Data Management, focusing in particular on the research issues in data quality monitoring for workflow systems on the Grid/Cloud.

Data quality is an important component of modern scientific discovery. Many scientific discovery processes consume data from a diverse array of resources such as streaming sensor networks, web services, and databases. The validity of a scientific computation's results is highly dependent on the quality of these input data. Scientific workflow systems are being increasingly used to automate scientific computations by facilitating experiment design, data capture, integration, processing, and analysis. These workflows may execute in grid or cloud environments, and if the data produced during workflow execution is deemed unusable or low in quality, execution should stop to prevent wasting these valuable resources. We propose an approach in the Kepler scientific workflow system for monitoring data quality and demonstrate its use for a range of application domains.

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### **NS1.1 :: Ramgopal Rao**

#### **Nano-composite polymer cantilever sensor platforms for low-cost health care and security applications**

CMOS scaling is expected to slow down owing to the huge cost, power and variability constraints. This has necessitated a paradigm shift in the CMOS scaling trends from the "More Moore" to the "More than Moore", allowing for the integration of heterogeneous technologies on a CMOS platform. The key idea is to achieve a functional diversification on the chip by empowering the CMOS technologies with a variety of "sense & interact" functions. In this talk we will look at the nano-electro-mechanical systems (NEMS) as one such enabling platform for sensor integration with the CMOS.

Many of the bio-chemical sensing applications require an ultra sensitive, low cost and disposable sensors. In this work we present a novel polymer process technology for realization of a highly sensitive nano-particle based piezo-resistive polymer composite cantilevers that can be fabricated at sub 100o C process temperatures, allowing for the integration of these technologies on a CMOS die. Electro-mechanical characterization of the fabricated microcantilevers yielded a resonance frequency which is a few tens of kHz and a deflection sensitivity in the range of 1 ppm ( $\Delta R/R$ ) for a nanometer of deflection. These cantilevers have been used for a range of applications such as for detection of explosive molecules such as TNT/RDX in the parts-per-trillion level of concentrations as well as for developing an integrated system to provide point-of-care diagnostic support for cardiovascular diseases. Prototypes of these systems are currently under development at IIT Bombay for field trials.

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## **NS1.2 :: Swaroop Ganguly**

### **Spintronics for beyond-CMOS logic**

Semiconductor spintronics seeks to leverage the spin degree of freedom of electrons to augment or replace conventional electronic devices. After pointing out the fundamental limitations to the scaling of traditional logic devices, I will provide a brief introduction to the field of spintronics and its promise to provide a workaround. Then I will focus on electrical spin injection and detection in semiconductors as the enabler for potential device applications.

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## **NS1.3 :: Dipankar Saha**

### **Ferromagnet/semiconductor spin based electronic and optoelectronic devices**

Spin based optoelectronic devices have found wide interest because of circular polarization of output light which can be controlled electrically and magnetically. Spin based lasers show better performance characteristics than their conventional counterparts. The talk will describe some of the interesting spin based light sources and their advantages in various applications. Spintronic lasers will be discussed in detail for their improvement on threshold current density, output circular polarization, enhanced modulation bandwidth and better large signal response.

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## **NS2.1 :: AS Khanna**

### **Effect of Nano-Additives on the Performance of paint coatings**

Two important ingredients of paint coatings are pigments and additives. The specific properties of paint coatings such as high corrosion resistance, UV blocking, superior mechanical properties are achieved by the addition of pigments and various additives. For example, ZnO addition in paint coatings gives inhibition properties to paint coatings and also helps in improving the resistance from UV light effect. Many such paints have about 10% of ZnO. The properties achieved are better than that of paint coating without having ZnO, however, these properties are still not the superior. It has been found that by the addition of 0.03% and nano ZnO, there was tremendous improvement in not only corrosion resistance, enhanced resistance to UV light and superior mechanical properties.

What is that which helps in improving these properties? One common explanation is that due to larger surface area of the nano additives, the effect of additives is better due to larger number of nucleation sites. Our results, however have shown, that in addition to the nucleation effect of large number of nano particles, there is change in surface roughness which helps in improving the mechanical properties and perhaps also influences the mechanical properties.

Several experiments using nano ZnO, nano silica and nano titania, we have found that at certain concentration of nano additives, there is a very uniform surface roughness and at this point, many of the properties of paint are improved substantially. Further we have found that grafting or simple dispersion of nano additives also makes a striking difference.

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## **NS2.2 :: Swapan Ghosh**

### **Nanotechnology for coating applicationNS**

Nanotechnology applicationNSin coatings have shown remarkable growth in recent years. Nanomaterial based coatings has already touched billion dollar market. When particles get small enough (qualify as nanomaterials), their physico-mechanical properties such as strength, weight, change of interaction with light, chemical resistance etc are enhanced. To achieve the expected functionality in the final coating layer it is very important to incorporate the nanoparticles homogeneously. The different properties that can be expected to enhance by using nanotechnology in coatings are: scratch resistance, abrasion resistance, mechanical properties, electrical and magnetic properties, UV protection, gas barrier, antimicrobial resistance, flame retardency, IR absorbance/reflectance, fluorescence, self-cleaning, water repellence, anticorrosive etc.

The present review will address the fundamentals of nanotechnology and show examples of how different properties of coating systems can be improved by using nanomaterials such as ZnO, SiO<sub>2</sub>, TiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, ITO, Fe<sub>2</sub>O<sub>3</sub>, CuO, ZrO<sub>2</sub>, Ag etc.

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## **NS2.3 :: Nick Birbilis**

### **Designing corrosion resistant light metals**

The past few years have seen efforts Monash aimed at the development of more corrosion resistant light metals. Such efforts are medium to long term, and can revolutionise transportation of both air and land vehicles, making them lighter and more fuel efficient. The Holy Grail of this effort is the development of stainless magnesium alloys.

This presentation will cover the work to date, summarising the successes, new insights and efforts that have contributed to this goal. We reveal how close we are to the goal, the remaining challenges, and future tasks ahead.

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## **NS2.4 :: Raman Singh**

### **Nanocrystalline structure for corrosion/oxidation resistance of steels**

This presentation will first develop an overall understanding of the role of grain size in oxidation of Fe-Cr microcrystalline alloys. Based on this understanding for microcrystalline grain size, the mechanistic role of nanocrystalline alloy grain size in oxidation resistance of Fe-Cr alloys will be discussed. An elaborate description of the presenter's own hypothesis that nanocrystalline structure can impart extraordinary oxidation resistance and the validation of this hypothesis will be presented. The data to be presented will include the results establishing that an Fe-Cr nanocrystalline alloy with only 10wt% Cr can provide as much oxidation resistance as an Fe-20Cr alloy, suggesting possibility of Fe-Cr alloys with the necessary corrosion resistance at much lower Cr contents.

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## **NS2.5 :: Sagar Mitra**

### **Nanomaterials and Energy Storage**

Recently, the role of nanostructured materials in addressing the challenges in energy and natural resources has attracted worldwide attention. In particular, oriented nanostructures demonstrate promising properties for energy harvesting, conversion, and storage. Although the applications differ from field to field, a common fundamental challenge is to improve the generation and transport of electrons and ions. The talk will highlight the role of high surface area to maximize the surface activity and discuss the

importance of optimum dimension and architecture, controlled pore channels, and alignment of the nanocrystalline phase to optimize the transport of electrons and ions.

The synthesis and application of oriented nanostructures for Lithium-ion batteries applications, the discussion on the challenges in attaining integrated architectures to achieve the desired performance will be highlighted.

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## **NS2.6 :: Huanting Wang**

### **Structurally Engineered Materials for High Performance Fuel Cells**

#### **(1) Nafion-carbon composite membranes for direct methanol fuel cells**

Nafion-carbon (NC) composite membranes were prepared by hydrothermal treatment of Nafion membrane impregnated with glucose solution. Nafion-carbon composite membranes exhibited improved proton conductivity and reduced methanol permeability as compared with plain Nafion membrane. The single cell prepared with the NC composite membrane with a carbon loading of 3.6wt% exhibited the highest cell performance. Compared with the cell performance of plain Nafion membrane, its maximum power density improved by 31.7% in the operation of H<sub>2</sub>-O<sub>2</sub> fuel cell at room temperature, and by 44.0% in the direct methanol fuel cell at 60 °C.

#### **(2) Nanoporous sinter-active layer for low temperature solid oxide fuel cells**

A nanoporous Ce<sub>0.8</sub>Sm<sub>0.2</sub>O<sub>1.9</sub> (SDC) layer with high sinterability was prepared on an anode-supported electrolyte film at 900 °C, and used as sinter-active layer in cell fabrication to improve the interface between the inert electrolyte surface and the cathode layer of solid oxide fuel cell (SOFC). The resulting saw-like interface improved the maximum power density of the cell by 51% at 600 °C and 162% at 500 °C compared with that of the unmodified cell. The cell with saw-like electrolyte-cathode interface exhibited lower electrode polarization resistance than those reported in the literature, and such improvement was much more significant at reduced operating temperatures (400-500°C). Our study shows that the operating temperature of solid oxide fuel cell can be substantially lowered by simply improving the electrode-electrolyte interfaces.

#### **(3) Eggshell membrane-templated perovskite ceramics for solid oxide fuel cells**

Highly crystalline perovskite ceramics were templated by an eggshell membrane (ESM) via strong metal-protein bonding. Templated Sm<sub>0.5</sub>Sr<sub>0.5</sub>CoO<sub>3</sub> (SSC) ceramic sheets had

an interwoven fibrous structure, and were used as a cathode material for solid oxide fuel cells (SOFCs). The maximum power density of the cell made with the templated SSC was 44.5% and 29.8% higher than that made with the conventionally combusted SSC at 600 °C and 500 °C, respectively, because the highly porous cathode constructed with the templated SSC reduced the cell concentration polarization and cathode polarization resistance.

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### **NS3.1 :: Rinti Banerjee**

#### **Nano medicine application for therapeutics**

Nanomedicine is an emerging interdisciplinary field which deals with the application of nanostructured materials in the development of newer diagnostic, regenerative and therapeutic modalities for healthcare. Nanoparticles have the potential to improve the diagnosis and treatment of various diseases, but the properties of each group of nanoparticles and their biological effects need to be finetuned and extensively evaluated to allow realization of this potential. Nanoparticles can be developed such that they are biodegradable and can penetrate through several anatomical barriers to reach otherwise inaccessible parts of the body. For example surface active nanoparticles can pass through the blood brain barrier and be used for delivery of drugs to the brain. Nanovesicle aerosols can be used for direct delivery of drugs by inhalation to the respiratory system including the deeper alveoli which minimize the systemic toxicity of the drugs. The uptake of different types of nanoparticles by the target cells can also be modulated by altering the surface chemistry of the nanoparticles. Increased endocytosis by the target cells can lead to improved efficacy of drug therapy due to the presence of nanocarriers. This talk will address the scope of biodegradable nanoparticles for therapeutic benefits in medicine, the current status of such carriers, their advantages, safety and translational issues and the future of therapeutic nanomedicine.

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### **NS3.2 :: Soumya Mukherjee**

#### **Evanescence wave optical bio-sensors for protein and bacteria detection**

Evanescence wave fiber optic biosensors exploit the fact when light experiences total internal reflection at the core- "cladding" interface, some of the energy of the light waves in the core of the fibre penetrate into the "cladding" for a very short distance and that evanescent wave power depends on the refractive index of the medium around the

core. Therefore, a part of an optical fiber from which the cladding is removed will be able to sense small changes in the refractive index (as may happen during a biological affinity interaction). We developed sensors for proteins and bacteria that further exploited the fact that all biological molecules absorb some light at 280 nm. Hence if an antibody is attached to the surface of the core, and an antigen (biological) interacts and attached to it, a larger amount of light at 280 nm will be absorbed. However, optical fiber sensors are fragile and developing sensors for widescale deployment is somewhat difficult adopting this technology. Therefore microfabricated optical sensors need to be developed.

SU-8 is an UV-patternable negative photoresist that can be (depending on viscosity and spin speeds) deposited with high thicknesses. Thus it is possible to create high aspect ratio structures using SU-8 directly or as a mold. This property, coupled to the fact that as a polymer SU-8 has a low Young's modulus leads to the possibility of creating high aspect ratio sensing structures using SU-8. From the transduction point of view such structures can be microcantilevers or optical waveguides. In this presentation we will discuss the evolution of microfabricated polymer waveguide optical biosensors from fiber optic biosensors. In the process, we have leveraged the phenomenon of LSPR while developing these sensors.

The ability of SU-8 in creating high-aspect ratio structures leads to the possibility of their being used to create optical waveguides. Traditionally microfabricated waveguides have been made of Silicon-di-Oxide. However, such structures are mostly extremely thin and coupling of light into such waveguides from sources and out from them into detectors have been exercises in dexterity and depended on the availability of high precision tri-axis positioners. High aspect ratio microfabrication can lead to thicker waveguides which may alleviate this problem. Accordingly, SU-8 waveguides of various shapes were patterned onto silicon wafers. Since it has been the experience that U-bend optical fibers provided better biosensing capabilities, U-bend waveguides were fabricated using a single mask process. The unique feature of these waveguides was that the waveguides also formed part of the wall of the microchannel which facilitated evanescent wave absorption based sensing. The waveguides were tested for evanescent wave based sensing using a variety of analytes like dyes, high refractive index solutions, biological molecules whose specific antibodies were immobilized on the waveguides. The shapes of these waveguides were further modified to provide higher light coupling which increased the sensitivity of the waveguide sensors.

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### **NS3.3 :: Jayesh Bellare**

#### **Nanotechnology and Nanomedicine for Healthcare**

Human health care products arising from nanobioengineering are having the most significant impact in the growing field of nanotechnology. However, several challenges delay or prevent speedy and efficient translation from bench to bedside. This is a broad overview of several of our ongoing investigations in the area of nanobiotechnology and nanobioengineering with therapeutic applications as the focus. Drug delivery with nanomedicines is one important area, but the ongoing investigations also cover a wide spectrum of biomaterials, thereby addressing both fundamental and applied aspects, since a fundamental understanding of nanoscale behavior is required so as to make an impact on applications which are sometimes very macroscopic, as in the case of bulk nanomaterials and devices.

The work is highly interdisciplinary in nature and is supported by a team with a broad range of expertise in both fundamental and applied areas including surgical and clinical aspects. Collaborators include: Prof. Sameer Jadhav, Prof. A.K. Suresh, Dr. S. G.Kane, Dr. Vivek Soni, Dr. Bharat Dalvi, Prof. Dulal Panda, Prof. Rinti Banerjee, Dr. Dhiren Bahadur, Dr. D. Dhome, Dr. S.Honvar, and several graduate and undergraduate students.

Among the areas covered are: Novel surfactants nanoparticles; Ophthalmic drug delivery; Nanocomposites for dental and orthodontics use; Micro-devices for cardiac use; and Nano particles in traditional and alternative medicinal systems (Ayurvedic Bhasmas and Homeopathy). The deliverables with health care impact will include: Nanoparticle and Polymeric anti-cancer drug delivery systems; Neonatal surfactant therapy product for respiratory distress syndromes; Eye-drops that reach the posterior chamber of the eye; Tissue-engineered dental and bone replacement with nanocomposites; Bone plates based on nanoparticulate bioglass; Mechanistic understanding of bhasmas and dilution; and microengineering for minimally invasive surgery.

From an application viewpoint, this work is at a preliminary stage due to the safety and regulatory issues involved, and extensive in-vitro and in-vivo trials are now needed to bring this closer to human applications. Still, we have been able to reach first-in-human trials. These diverse examples show the immense power and potential that nanotechnology has in healthcare.'

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## **NS3.4 :: Ben Boyd**

### **An overview of nanotechnology and nanomedicine research at the Monash Institute of Pharmaceutical Sciences, Monash University (video)**

Monash Institute of Pharmaceutical Sciences (MIPS) conducts research across drug delivery, drug discovery and drug optimization fields, with a focus on translational research. The intersection of nanotechnology and drug delivery, i.e. nanomedicine, is an important sub-field of drug delivery. In this presentation MIPS will be briefly introduced, and the major fields of nanomedicine research will be highlighted and a number of examples of research outcomes presented to facilitate identification of potential areas of collaboration through the IITB-Monash Research Academy.

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## **NS4.1 :: A. K Suresh**

### **Transport in nanofluids: Some results on mass transport**

Nanomaterials have evoked much interest in various technological applications in recent years because of the peculiar properties that matter often exhibits when reduced to nano-dimensions. The transport properties of nano-materials in suspension (i.e., nanofluids) are among such properties of particular interest to chemical engineers. Literature has accumulated on the heat transfer properties of nanofluids with claims and counter-claims on anomalous, particle-size dependent enhancements in thermal conductivity and heat transfer coefficients. The parallel literature on mass transport properties is more scarce by comparison, and on the whole, even more confusing. In this talk, we will describe systematic studies using model apparatuses and model reactions to explore the behaviour of nanofluids in gas-liquid mass transfer. Experiments have been conducted in a variety of situations, spanning several contactor types, gas-liquid systems, levels of diffusion limitations, and hydrodynamics. A correlation that satisfactorily brings together all the data in the above situations shows that the particle size scaled with respect to the diffusion depth of the solute is an important parameter in determining the mass transfer rates.

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## **NS4.2 :: Murali Sastry**

### **Nanotechnology and India**

Nanotechnology has moved from a phase of hype to one of cautious optimism. Indeed, there are more than 400 nano-enabled products in the market today with promise of many more to come. In this talk, I would like to discuss what nanotechnology could mean to a country like India. I will begin by addressing the most pressing needs of our country using a study conducted by Singer et al on the role of nanotechnology in developing nations as a backdrop. Promising nano-enabled innovations that address these needs will be discussed as well as some of the initiatives that are currently underway to spur such innovations. I will then conclude with a very brief discussion on Swach, the low cost nano-enabled water purifier that my team had contributed to.

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## **NS4.3 :: A Q Contractor**

### **Conducting Polymer Nano Structures**

Conductors at nano dimensions exhibit remarkable non-bulk properties; this is another level of novelty one can add to organic conducting polymers. Polyaniline is a one dimensional conductor at the molecular level; however fibres and films can exhibit isotropic behaviour as well as anisotropic behaviour depending on the synthesis conditions. These have implications for many applications particularly, transducer applications. Some examples from our work will be described.

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## **DS5.1 :: Subu Goparaju**

### **Tomorrow's Enterprise: Innovation for more sustainable and inclusive growth.**

As more people enter the global economic activity there are many opportunities for growth for organizations. But the innovation models that probably worked in the past are unlikely to be effective in the future. The most recent Global Risk report from the World Economic Forum mentions "Economic disparity" and "Global governance failures" as the two highly connected risks with a potential for high impact. Therefore organizations must focus on innovation models and technologies that lead to more sustainable and inclusive growth. From a sustainability perspective the innovation must help produce low resource intensity, green products and offerings. From an inclusivity

perspective innovation must help provide essentials such as food, water, energy, healthcare, financial services etc to all in affordable manner. These are global grand challenges. Information and communication technologies can play an important role in addressing these. The combination of a huge elastic computing power in the cloud and the ability to embed computing and communication capabilities into almost anything around is helping create new innovative products, processes and business models. If leveraged well they can help address the global grand challenges very effectively. Many organizations both big and small and innovators are already engaged in this research and innovation.

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## **DS5.2 :: Aravind Sitaram**

### **Enabling Inclusive Growth through technology**

Inclusive growth is aimed at ensuring the non-enabled population is integrated into the mainstream economy by driving the agenda of economic inclusion and helps provide access to basic and affordable amenities such as education, healthcare and public services. In emerging countries, inorganic means are required to drive economic & social inclusion which promotes economic growth & sustainability.

In the coming decade, an estimated population of three billion from emerging countries will join the world economy. This demographic shift will further influence & drive the global market transitions. New business models, new ecosystem of partnerships, technology and evenly distributed robust infrastructure will be an imperative to transform the nations and help accelerate the capabilities of the population to integrate and partake in the overall economic development. We need to look at evolving new technologies and business models to help drive the agenda of economic inclusion and in turn create social and economic stability.

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## **DS5.3 :: Arun Pande**

### **Role of IT in bridging the gap between the rural and the urban**

Urban India has been growing with a healthy growth rate of 8 to 9% while rural India is struggling to reach growth rate of even 3%. This leads to uneven economic development of urban and rural areas. The author had visited several villages and met farmers, agri

input companies, NGOs, Government extension workers and agriculture university faculty members. It seems there is an urgent need for time specific, location specific and personalized advice / information to be made available to farmers. Author will explain how mKRISHI platform connects farmers and stakeholders and bridge the gap between them. Also, he will explain how mKRISHI platform enables small and marginal farmers to use precision farming to increase their yield.

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#### **DS5.4 :: Anant Chilkunda**

##### **Digital Divide among the Digital natives**

As India adds millions of new mobile users every year, the aspect of "access" and "access device" is now no longer a primary issue for digital divides in India. In this brief talk, we will look at some of the challenges and opportunities to narrow the digital gaps in the field of Consumer, Enterprise and Rural populace in India.

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#### **DS6.1 :: Santanu Sarkar**

##### **Cloud Computing and Desktop Parallelism: Bridging Digital Divide – IT Industry Perspective**

In the current decade, computing infrastructure is undergoing a sea change. On one hand, computing power is increasing by orders of magnitude through more and more "cores" rather than increasing clock speed of a single CPU. On the other hand, highly specialized graphics processors (GPUs) with a massively data parallel architecture, is being used for general purpose computing. Many-core CPUs and GPUs, with supercomputing capabilities are now available in a desktop at a highly affordable price. In parallel, as economic recession loomed large, business was forced to reduce the capex and opex on IT infrastructure and started to look for cost-effective means of computing- be it a business application, a massive number crunching scientific computing, or huge data crunching operations on petabytes of data. This impending need ushered a revolution in computing, namely the Cloud Computing. Loosely speaking, the cloud computing supports elasticity in computing demands, where one can rent a computing infrastructure of any configuration, at any time, on a pay-per-use basis at an extremely cheap price.

This paradigm shift in computing infrastructure is going to influence the digital divide in a large way, as Bloomberg and IDC predict a new market opportunity of \$15B in a few years time. On one hand, corporations like Intel, IBM, Amazon, Microsoft, Google, Oracle, NVIDIA, Verizon, are going to bring on-demand, per-per-use, high performance

computing infrastructure to a larger population at an extremely attractive cost-performance ratio. This in turn, will create greater demand for large class of applications in complex scientific computing, massive data analytics, customizable business processes on-demand and so on from a much larger part of the planet's population, rather than from a niche segment.

This game-changing phenomenon is going to have a profound and disruptive impact on the way software is going to be built, provisioned and maintained for tomorrow's enterprise. In order to harness the power the massively parallel architecture like multi-core, GPU or massively distributed data-cloud such as Hadoop, one needs to adapt to a different programming paradigm, which are many times harder to understand and manage. Clients, in general are sceptical about the security and privacy issues in the cloud. IT services organizations that are responsible for application and infrastructure management, need to provide a cost-effective and optimal usage of data centres, preferably on a shared platform. This will have implications on application level SLA. This talk will give an overview of the paradigm shift, its challenges and research questions that the distributed computing research group aims to address.

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## **DS6.2 :: Peeyush Ranjan**

### **Digital Divide: Technology as a bridge**

"Internet as a technology has positively impacted the lives of a 1+ Billion people in the world, by informing, entertaining, and connecting people. Unfortunately, we have not had the opportunity to touch the lives of the other 5 Billion who are not connected to the Internet. The Digital Divide is the widest where emerging internet users have not derived the maximum potential from the power of information via the internet.

There continues to be a Digital Divide despite the falling prices of devices and connectivity, primarily because:

- Internet is not Relevant: There is dearth of local information, plenty of access challenges and lack of contextually relevant applications.
- Lack of awareness of the value of internet/information: User need to overcome the current mindset that "computers" are for urban, english literate elite.

Our approach to bridging this divide involves developing solutions that make the internet relevant to new users and also improve the underlying awareness about the power of information.

This talk will throw light on factors contributing to digital divide, how can we fill the gaps on the internet to bridge the digital divide and Google's endeavors in doing so.

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## **DS6.3 :: Joy Deshmukh**

### **TCS Adult Literacy Programme**

Computer Based Functional Literacy (CBFL) is a multimedia-oriented software package, an eLearning system for helping adult illiterates who speak the language under purview to learn the 3 Rs. TCS' CBFL was first pioneered in Beeramguda in Andhra Pradesh in 2000 and has since been devised and improved over the past ten years. CBFL has been tested in nine Indian languages and about 1.5 lakh adult illiterates have been directly taught through the efforts of Tata Consultancy Services Ltd. (TCS) jointly with State Literacy Mission Authorities (SLMAs) functionaries and a few NGOs.

The National Literacy Mission Authority (NLMA), researched the problem of uniformly teaching adult illiterates all over the country the 3 Rs in the language they speak. The State Resource Centres (SRCs) produced primers in Indian languages that have been approved by NLMA as incorporating their methodology. The pedagogy embedded in these primers is to learn / discover new things from the known and progressively advance towards being able to read or write in the language in question. TCS adopted these primers to experiment with multimedia as a teaching medium, to experiment with the role of technology in speeding up instruction, and with the hope of assisting untrained instructors (preraks) to deliver better than average levels of instruction. This is what we call CBFL.

The National Literacy Mission Authority (NLMA) Saakshar Bharat (Literate India) scheme targets making 70 million persons literate by 2012. In this connection they wish to use the TCS Computer Based Functional Literacy (CBFL) Programme to accelerate the process of ensuring total literacy through literacy camps across India.

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## **DS6.4 :: Manish Gupta**

### **Spoken Web: A Parallel Web for all**

In India and several other countries, most notably in Africa, the penetration of the personal computer and the internet remains relatively low. However, there has been a huge surge in the adoption of simple mobile phones (there are over 700 million mobile

phone numbers in India), and this penetration continues to grow at a fast pace. We will present Spoken Web, an attempt to bridge the digital divide and create a new world wide web for the masses in these countries, accessible over the telephone network and hosted in a cloud. The Spoken Web platform facilitates easy creation of user-generated content that populates “voice sites”, and allows contextual traversal of voice sites interconnected via hyperlinks based on the Hyperspeech Transfer Protocol. We present our experience from pilots conducted in villages in Andhra Pradesh, Gujarat, and other states in India. These pilots demonstrate the ease with which a semi-literate and non-IT savvy population can create voice sites with locally relevant content, including schedule of education/training classes, agricultural information, and entertainment related content, and their strong interest in accessing this information over the telephone network. We describe several outstanding challenges and opportunities in creating and using a Spoken Web for facilitating exchange of information and conducting business transactions.

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## **DS7.1 :: Sundar Ramakrishnan**

### **Network Technology Enablers to Bridge the Digital Divide via Cloud Computing**

Every technology or business journal today has some commentary on cloud computing – what it is, and how it will change IT, business and bring about easy availability of lower cost computing resources. In our increasingly web-dependent society, some of the critical factors impeding the transition of online applications to the cloud are ease of deployment of new services, the need to assure constant availability, and the ability to deliver exceptional performance to end-users.

The cloud is a holistic ecosystem of components, not a point product. It includes, on the server-side, inexpensive storage, plentiful CPU bandwidth, massively scalable and intelligent networking infrastructure, etc., and on the client-side, reliable broadband connectivity, ability to execute sophisticated client-side algorithms such as HTML-5, etc.

Brocade Communication Systems is a pioneer in developing computer networking technologies that enable the evolution of computing architectures to support moving of services, computation and data to a location-transparent, ubiquitous-access paradigm. This allows service delivery to view IT as OpEx rather than CapEx, lowering costs, and enabling opportunities for enhanced collaboration, integration and analysis on a shared, common platform. Further, Brocade’s solutions provide ways to optimize the performance of applications in the cloud, ensuring application availability and reliability which are critical for optimizing high-scale production environments in the cloud.

Just as the mobile phone has significantly contributed to eroding the communication divide, availability of location-independent data storage and computation power, combined with interesting applications that can be delivered reliably via wired or wireless networks to inexpensive smart devices can transform society's current need to bridge digital have-nots with the haves. And, as with mobile phones, it is not only the price of devices, but the ability to deliver secure, value-driven applications with trustworthy performance that will fuel adoption of services necessary to bridge this divide. Brocade provides technologies that enable these attributes for enterprises and service providers to quickly roll out such solutions.

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## **DS7.2 :: Ajit Balakrishnan**

### **Is India's Digital Divide Socially Constructed?**

The term 'Digital Divide' is often used to mean a condition caused by technological problems and thus needing a technological solution such as cheaper PCs and more pervasive broadband. We will conjecture whether it is in reality a socially constructed legitimizing myth like 'Population Explosion' or 'Magic of the Market' and thus needing deconstruction before we search for solutions.

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## **DS7.3 :: Ashok Misra**

### **Excitement in Creativity and Invention in the context of Digital Divide**

Advances in science and technology have led to globalization and increased the reach as well as power of knowledge. Knowledge has spread faster than people or capital and with this by-and-large the world stands to gain. In this process it is the creation of specialized knowledge that is rate-limiting – this is where the innovators play a role. Several of the larger world economies have shown that a steady cycle of innovation is the key to a country's future economic well-being – as evidenced by the impact of inventors from Graham Bell to Robert Noyce. The key to ensuring that innovators and inventions are widespread is an educational system that ensures that the brightest scientists, faculty and students are attracted to and flourish in institutions of higher learning. Ideally, the new ideas that then spawn from this pooling of intellect are the engines that drive new technologies, and eventually enterprise and employment. Individual gains in science and technology need not always be extraordinary – the transition from an 8080 Intel processor in 1975 with 10,000 transistors on a sliver of silicon, to today's billions-of-transistor multi-core processors with over 10,000,000 transistors packed into an area the size of the period at the end of this sentence, has been made through a process of continuous improvement, eventually dramatically

reducing computing cost per instruction, and rendering the computer an ubiquitous productivity-enhancing and world-shrinking necessity in the modern world.

So then, what is a good invention? Generally speaking, it is a product of exercising the imagination to create something novel that is intellectual in origin that is beyond the obvious, has inevitable context and can be adequately protected and realized in practice. Good ideas can very well come from anyone, and any place – with academic faculty, students, entrepreneurs and tinkerers in garages all being proven, likely sources! While great inventors are a rare breed, what is of equal importance to facilitate the invention process is discovering these people and places, wherever they may be, and bringing these inventors and their ideas to the world table. A systematic process has to be in place to tap the ideas in a form that can benefit all of mankind.

The naysayers may argue that the ‘Golden Age of Invention’ – the late 19th century to the end of the 20th, is past, with the ‘simple’ light bulb, the telephone, the aeroplane, the radio, the television, the integrated circuit, polymers and dramatic advances in medicine and countless thousands of other technological advances all having occurred in its course. The truth is that the world still starves for more inventions and ideas. Food scarcity and its poor distribution, water shortages looming large on the horizon, an impending energy crisis and the delicate ecological balance, along with the thus far unbridged digital divide, are only a few of the significant challenges that readily draw our attention – all needing the scientific community to roll up its sleeves and innovate and invent.

In the context of India – where 70% of the country lives in villages, the digital divide is stark. While there has been progress owing to improved access to information in some regards- farmers and fishermen with access to weather and season forecasts, and to the fair market price for their produce, there are still several challenges. The problem is an interconnected and therefore complex one. For examples - remote healthcare, education, banking and other services have all been proven to be possible (there is still a long way to go), but without steady or at least predictable power supply, these are of limited use. Likewise, internet access assumes a phone connection, rarely a given. This throws up two obvious areas (of several) to innovate – to further lower the costs of decentralized power generation and of remote telephony and connectivity for the hundreds of millions of India in our villages. Opportunities abound for the willing and able innovator.

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## **DS7.4 :: Nagarajan S**

### **Harnessing technology in the Animation & Visual Effects Sector**

Animation and Visual Effects (VFX) is a technically demanding domain in addition to being artistic and creative. Companies can succeed in this area by harnessing technology smartly to add to their creative capabilities and production efficiencies. Using the experience of Tata Elxsi's Visual Computing Labs, which services both the Hollywood and the Bollywood markets, the talk will highlight some of the challenges which are faced by this industry in India in the technical domain, resolving which can provide substantial competitive advantage to the Industry.

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## **DS7.5 :: Michael Brunig**

### **Smart Sensing & Informatics for Water Storages**

Understanding and managing dams and their surrounding catchments is vital to ensure safe drinking water for the community and the long term viability of this most precious resource. However doing so effectively requires timely, plentiful, accurate data. Traditional methods of data collection, most of which involve manual sampling, provide only limited spatial and temporal information. Until now it has been difficult, if not impossible, to measure all the relevant variables on and in the water and within the catchment.

We present a cost-effective, accurate, fully integrated, scalable, automated environmental monitoring system to remotely monitor water quality, event flows and greenhouse gas emissions in real-time. A proof-of-concept system has been installed on and around Lake Wivenhoe, Brisbane's major source of drinking water. This integrated sensor network, dubbed iSnet, comprises 120 static nodes (some floating on the dam, some in the surrounding catchment), 30 mobile nodes (attached to collars worn by cattle grazing in the catchment) and an autonomous robotic catamaran which gathers data between the nodes and performs maintenance, calibration and other tasks on them. The nodes work independently to record environmental variables and cooperate with each other to set up an ad hoc network to wirelessly transfer data to four base stations on the shore. The base stations use the 3G mobile phone network to upload this data to a remote database that can be accessed over the Internet. This deployment is providing the water authority with a world first capability for continuous, real-time, remote observation, analysis and visualisation of environmental variables at high spatial and temporal sampling density. It is also the first system of its kind to allow whole-of-storage monitoring of greenhouse gasses.

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## **DS7.6 :: Ashwin Gumaste**

### **Broadband in India: Sparse and Farce**

India – home to 1.2 billion people and a GDP growth of 9%, has been experiencing flat to modest growth of broadband services in the past decade, this despite the fact that India continues to add 8-10 million cellular connections per month. In this paper, we examine the reasons that affect the high-cost of broadband in India and steps required to reduce the same. We also argue that the usage based pricing model, which is widely used for billing retail customers in the country, is hampering the growth of local content and services. On the contrary, a flat rate pricing model will spur demand for broadband services and enable content providers to target the local and emerging market. We study the Indian telecommunication scenario from a pricing and technology perspective and understand what the driving forces are for business to prosper. We then discuss the Indian landscape from a metro/access/core networks perspective. The technology choices and the methods of deployment are considered followed by an analysis on the service-centric model adopted by providers.

We extend our well reported earlier work , where we analyzed the causes of the problem of broadband penetration in India, and propose a comprehensive solution to the same. Specifically, we understand the problem from a business perspective, and then propose a novel techno-business model leading to the solution of the broadband problem in India. We show the detailed working of the solution and postulate reasons for its acceptability and success. A detailed simulation study considers our solution and compares it to contemporary approaches – showing a Return-On-Investment (ROI) improvement in our solution. We also show the technological advantages experienced through the implementation of our solution vis-à-vis existing broadband deployments in India as well as other developing countries.

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## **NS5.1 :: Juzer Vasi**

### **Overview of Nanoelectronics at IIT Bombay**

This talk will give an overview of the activities in nanoelectronics at the "Centre of Excellence in Nanoelectronics" at IIT Bombay. This will include a brief description of facilities, areas of research, and satellite programmes, as well as ongoing and potential engagements with industry. The talk will also touch upon recent initiatives in photovoltaics at the "National Centre for Photovoltaic Research and Education" at IIT Bombay.

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## **NS5.2 :: Malin Premaratne**

### **Light propagation in nano-sphere chains and nano-wires**

Miniaturization of photonic elements to sub-wavelength size (i.e. nm size) and repeating the functionality of high density electronic circuits requires fresh thinking and mind-set to break physical barriers including diffraction limit. In this talk I will review the recent advances (mostly my work) in confining and guiding light in sub-wavelength structures. Metal nano-wires and metal nano-spheroidal chains are the building blocks of this new path. To illustrate the applications of some of these ground breaking concepts, I will discuss how energy can be coupled to nano-wires/spheroidal chains and efficiently guided along straight lines; around a corner; split at forked structures; radiated out using nano-antennas. Once integrated onto a chip, these structures can be used to make complex optical processing circuitry with dimensions comparable to the wavelength of the light, surpassing the capabilities of the conventional technology.

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## **NS5.3 :: R Vijaya**

### **Laser emission from self-assembled photonic crystals**

Photonic crystals grown using self-assembly from Rhodamine-B dye-doped polystyrene colloids show a systematic angle-dependent suppression of spontaneous emission in the wavelength range of the photonic stop band, an enhancement at the band edge, spectral narrowing and a laser threshold when excited with the second harmonic of Nd:YAG laser. These miniature lasers are grown within 3 hrs in ambient conditions.

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## **NS6.1 :: PS Gandhi**

### **Microstereolithography**

Several MEMS and NEMS (Micro Nano ElectroMechanical System) devices are making revolutionary changes and new innovations in applications in several including biomedical (micro-nano fluidics), sensors, optomechanics, to name a few. These developments are enabled by progresses made in the technologies of fabrication. Conventional processes mainly enable fabrication of 2D or multiple layers of 2D devices in polymer or other materials. However novelty of several applications including biosensors, microchannels/ turbines, actuators, 3D optics waveguides can be enhanced if technology for fabrication of 3D micro-structures is available. This talk focuses on a novel (patent pending) microstereolithography technology for fabrication of high resolution, high range 3D micro components. It presents various aspects of this

technology, research and application avenues and several microstructures fabricated using this technology at Suman Mashruwala Advanced Microengineering Laboratory IIT Bombay.

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## **NS6.2 :: Nikhil Medhekar**

### **Structure, Composition and Electronic Properties of Nanoscale Materials: Self-assembled Alloy Quantum Systems and Graphene**

Self-assembled nanoscale quantum alloy systems, such as quantum dots, wires, and fortresses, are drawing significant attention for their potential application in the next generation optical, electronic and photovoltaic devices. Current scientific and technological interest in these nanoscale systems is driven by the novel quantum mechanical phenomena associated with their nanoscale feature lengths. The electronic properties of these quantum systems are strongly influenced by their shape, elastic deformation, and, more importantly, by their composition. However, it is challenging to obtain a quantitative description of composition profiles due to the coupling between composition variations, shape, and long-range elastic interactions.

In this talk, I will present an efficient multiscale approach that combines finite element analysis with an optimization scheme to determine equilibrium composition profiles in strained quantum dots. Composition profiles are found to strongly depend on the shape of the quantum dots. For instance, strain relaxation in dots with steeper sidewalls allows for the segregation of the larger alloy component in the region near the apex. Further, based on first-principles calculations, we find that the nonuniform composition strongly alters the quantization behavior. Our studies suggest that the novel quantum confinement phenomena that are otherwise only associated with length scale of a few nanometers can be achieved in much larger structures.

In the latter part of the talk, I will present a brief overview of my current research in graphene and related materials. I will focus on how the atomic-level structure influences large-scale electronic and mechanical properties of these materials.

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## **NS6.3 :: Cordelia Selomulya**

### **Designing functional particles: properties and applications**

The design of functional particles for applications including medical diagnostics and therapeutics, food, and security are presented. Examples are given of research activities to functionalise magnetic nanoparticles for bio-applications including enzyme immobilisation and vaccine delivery, magnetic nanocomposites for electromagnetic interference (EMI) shielding, and nano-structured catalysts for fuel conversion. Applied research in functional dairy powders illustrates the capability to conduct strategic work pertinent to national benefits, specifically in regard to the dairy industry in Australia. Unique to the Department of Chemical Engineering, Monash University is the capability of low temperature drying approach for single-step assembly of multifunctional systems including photoluminescent microcomposites and microencapsulates for controlled drug release.

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## **NS6.4 :: Gil Garnier**

### **Nanoparticles for bioactive paper**

Bioactive papers have recently attracted tremendous interest for their potential in delivering low cost, high selectivity and flexible platforms of disposable biomedical assays. Recent developments at APPI-BioPRIA include paper diagnostics for instantaneous blood typing and antibody analysis. A drawback of paper tests is their typical low sensitivity compared to medical laboratory techniques. ELISA and metal nanoparticles have been investigated to remediate this weakness and increase sensitivity by orders of magnitudes. In this presentation, recent progresses with metal and gold nanoparticles (AuNP) functionalized papers are presented with a special interest for Surface Enhanced Raman Spectroscopy (SERS) and Surface Plasmon Resonance (SPR) biomedical applications.

The AuNP surface coverage, state of aggregation and 3D distribution on paper were varied using polyelectrolytes (type, concentration) and by varying the application process (ink jet printing, paper soaking, surface treatment). The AuNP distribution on paper was characterized by image analysis. A dye, 4-aminothiophenol (4-ATP)- used as model for biomolecules-, was adsorbed onto the AuNP functionalized papers and analyzed by SERS. With AuNP, reproducible spectra were achieved with the intensity-sensitivity increase by up to 5 orders of magnitude compared to untreated paper. AuNP aggregation state on paper appears as the dominant variable affecting SERS intensity.

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## **NS6.5 :: Mainak Majumder**

### **Engineering with Nanocarbons: Carbon nanotube based membranes and functionalized graphene materials**

Graphene – a one atom thick sheet of carbon atoms and carbon nanotubes – a rolled up cylindrical version of these graphene layers have attracted considerable attention in recent years. These materials possess several outstanding properties such as high electrical conductivity, excellent mechanical strength, high thermal conductivity as well as large surface area and well defined crystallographic structure.

Our laboratory is focused on developing carbon nanotube based membranes for fluid filtration applications. These membranes are composed of vertically aligned carbon nanotubes embedded inside an impervious polymer matrix such that fluid flow occurs through the inner core of nanotubes. Given the abilities to control the dimensions of these nanopores, and functionalize the nanotubes with chemicals of interest, these novel architectures can spawn myriad applications in nanofluidics, nanofiltration, and drug-delivery.

A potential route to large scale synthesis of graphene is through oxidative chemical exfoliation of graphite and subsequent chemical or thermal restoration of their  $\pi$ -bonds. Our group is dedicating efforts to reclaim natural graphitic fines from Australian mines in creating novel functional materials. I will discuss our recent work on the development of novel graphene based adsorbents through soft chemistry principles for water purification applications in developing economies.

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## **NS6.6 :: Ajay Panwar**

### **Selective Transport through Nanopores**

Biology offers several examples of extreme specificity and selectivity that if mimicked in engineering processes can be translated to high-throughput separation technologies. A unique example of highly selective and regulated transport is the nuclear pore complex (NPC), which regulates the transport of RNA and proteins between the nucleus and cytoplasm in eukaryotic organisms. The NPC is a self-assembling super-structure that is formed on a lipid bilayer membrane and has an internal diameter in the range of 30 - 50 nm. Although the exact physical mechanisms are unknown, the NPC is believed to use

both specific interactions and entropic effects to control mass transport across it. The inner walls of the central pore are covered with hydrophobic unfolded domains that can be likened to terminally-anchored hydrophobic polymer brushes. We use molecular simulation and a minimal NPC model to gain mechanistic insight into the NPC organization and transport problem at various length scales. Such insight could guide the development of artificial ultra-specific separation processes.

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## **NS7.1 :: Swapan Ghosh**

### **Challenges of nanotechnology for the coating Industry**

For the past decade there has been a lot of interest in exploiting the unique properties of nanoparticles. The term 'Nano' has already crossed its scientific domain and entered into our day to day life products. However, progress in creating commercially viable coating products based on nanotechnology has been slow for several reasons such as: fulfilling customer expectations, to obtain a stable dispersion that lends the nanoparticles to be incorporated homogeneously into the resin/binder system, cost efficiency, health and safety aspects and possible legislation impacts.

The most critical aspect of using nanoparticles is the health and safety issues due to their nanometer size. To handle this matter, several research activities are ongoing and many new regulations/standards are proposed.

This talk will look at the different aspects that influence the marketability / large scale acceptability of coatings based on nanotechnology.

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## **NS7.2 :: Raksh Vir Jasra**

### **Nanoscale Effects in Catalysis**

The emergence of nanomaterials has hugely impacted the field of catalysis, particularly heterogeneous catalysis, in terms of enhancing the fundamental understanding of the nature of catalytic active sites and hence tailoring a catalyst with the desired activity and selectivity. Changes in the local electronic and physical structures of a solid brought about by "nanostructuring" have a tremendous impact on heterogeneous catalysis, as observed in case of Au for selective oxidation; arene and alkene hydrogenation by Ir, Rh; photocatalytic activity of TiO<sub>2</sub>, and unique reactivity of oxide nanoparticles. The present

talk will focus highlighting the important linkages between catalytic behavior such as activity, selectivity with nanoscale catalyst attributes like particle size & shape, crystals facets & defects, particle- support interaction/confinements. Talk will be mainly focused on traditional catalyst systems used in industry for diverse organic transformations.

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### **NS7.3 :: Beena Rai**

#### **Design of Highly Selective Biosensors**

Protein–surface and protein–protein interactions are essential for a wide variety of applications such as biosensors, biomedical implants, immunoanalytical tests and many other industrial processes. Limitations such as low sensitivity or selectivity in biosensors or immunoassays, or the loosening of bio-implants, are often a result of non-specific protein–surface and protein–protein interactions. Study of protein–surface interfaces is hence very important, both from fundamental and application point of view. Various experimental techniques are employed for this purpose. We present our results on Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) spectroscopy studies on the conformation of adsorbed proteins. Molecular modeling is used as a complementary tool to gain further insight into the conformation of adsorbed proteins. These results are utilized for designing highly selective immunoassays and biosensors. The utility of our approach is illustrated through the results of our efforts in developing a biosensor for sugar molecules.

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### **NS7.4 :: Sunil Ashtekar**

#### **Nano Enabling Opportunities in the Energy World & the importance of Safety**

While nanotechnology has made a positive impact on many industries such as medical, aircraft, consumer, electronics and pharmaceutical sectors, and has the potential to grow further and can significantly impact the oil and gas industry space in coming years. Nanotechnology is yet to be exploited to its full potential in the energy industry and the safety around nanotechnology holds a strategic importance in delivering the success. The relevance of other established nano enabled technologies from other industrial sectors provides a vast opportunity for the oil & gas industry, will be the objective of the presentation.

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## **NS7.5 :: Mano Manoharan**

### **Nano-enabled manufacturing: Transitioning from Science to Products**

Human progress over the centuries has often been based on mastery over materials, so much so that from the Stone age to the Iron age to the age of silicon, time has been marked by the type of materials that dominated the world at that time. As we move into the new century, this basic paradigm remains unchanged, though now the range of materials that influence our life is much wider. The developments in nanotechnology provide a unique opportunity to not only develop new classes of materials but also do so in harmony with a goal of sustainable development. There is, however, a large gap between the promise of nanotechnology and its integration into a new generation of nano-enabled products. This talk will focus on the promise of nanotechnology as viewed from an industrial research perspective and also examine some of the challenges in setting up a nano engineered value chain, which is critical for a new generation of nano-enabled products.

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## **NS7.6 :: Amit Biswas**

### **"Nano-Enabled" Energy & Materials Technologies: A Reliance Perspective**

To meet current and future needs of consumers in the 21st century, it is necessary to understand and optimize the entire value added chain of energy and materials, i.e. from the development of sources, to conversion, distribution and storage, all the way up to utilization by consumers. Nanotechnology, as an enabler, has the potential for decisive technological breakthroughs in the energy and materials sector. Reliance, as an emerging global player in energy and materials, has a keen interest in leveraging nanotechnology to meet the needs of its customers and stakeholders. Various examples of nano-enabled technologies across the entire value added chain, in the Reliance context, will be discussed.

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