Theme 7

Advanced Air-interface Techniques – OFDM, MIMO, and Co-operative Communications

IITK, IISc, IITM
CEWiT, Sasken, Midas

U.Southampton, U.Surrey, BT

Mysore, January 25&26, 2011
Summary

- **Research papers**
  - From India partners: 12
  - From Indo-UK partners: 1
  - From UK partners: 25

- **Research topics**
  - Channel Truncation for OFDM → IITM, IISc
  - MBER based MIMO precoding for relay/estimation/symbol detection → U.Southampton, IISc, IITM
  - Non-coherent estimation (pilot-less or less pilots) → U.Southampton, IITK
  - Smart scheduling, Co-operative scheduling/communications → U.Surrey, IITM, IITB (Theme9), CEWiT
  - Robust channel estimation → CEWiT, IITM
  - Interference aware network coding → IITM, U.Southampton
  - Video coding for multicasting in LTE/LTE-A → IITK, IITM

- **Patents filed/to be filed**
  - Robust channel estimation → filed by IITM & CEWiT
  - Channel Truncation for OFDM → to be filed by IITM
  - Robust LLR estimation → to be filed by IITM

- **Impact on Standards:** The work, on OFDM channel truncation, will be used in defining contributions to LTE-A where a mixture of large CP and short CP sub-frames can be used within a frame to enable spectrally efficient deployment in large rural cells, as well as for enabling co-operative multipoint transmission

- **Commercial impact:**
  - Many algorithms developed in Theme 7, such as enhanced channel estimation, robust LLR estimation, smart scheduling, will be implemented on the 4G testbed at IITM (Theme 10)
  - One of the algorithms being developed in Theme 7 (OFDM channel truncation for large delay spreads) is being ported by a Master’s student to the hardware being developed as part of the 4G testbed in Theme 10.
  - Middleware for efficient video multi-casting can also be implemented on testbed → demos
Theme 7

Background Material

Mysore, January 25&26, 2011
### Indian Partners (from Oct. 2009)

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th># of research staff</th>
</tr>
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<tbody>
<tr>
<td>K.V.S. Hari</td>
<td>IISc Bangalore</td>
<td>1 + 1*</td>
</tr>
<tr>
<td>Kasturi Vasudevan</td>
<td>IIT Kanpur</td>
<td>1</td>
</tr>
<tr>
<td>Srikrishna Bhashyam</td>
<td>IIT Madras</td>
<td>5 + 3*</td>
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<td>Andrew Thangaraj</td>
<td>IIT Madras</td>
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<tr>
<td>K. Giridhar</td>
<td>IIT Madras</td>
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<tr>
<td>Sheetal Kalyani</td>
<td>CEWiT</td>
<td></td>
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</tbody>
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* for these scholars, their salaries are paid from Govt scholarships

Industry partners involved from India in this theme are CEWiT, Sasken, Midas
## UK Partners (from Jan. 2009)

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th># of research staff</th>
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</thead>
<tbody>
<tr>
<td>Lajos Hanzo</td>
<td>U.Southampton</td>
<td>1</td>
</tr>
<tr>
<td>Mehrdad Dianati</td>
<td>U.Surrey</td>
<td>1</td>
</tr>
<tr>
<td>Santosh</td>
<td>BT</td>
<td>1</td>
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Theme 7 – Research Areas

1. Mr. Istdeo Singh (PhD scholar) – Channel Truncation for OFDM
2. Ms. Bama (PhD scholar) – Network Coding
3. Mr. R. Sai Shankar (PhD scholar) – Enhanced Channel Estimation
4. Ms. J.S. Vaishnavi (MS scholar) – MBER based Interference Cancelling
5. Mr. N. Hariram (PhD scholar) – Game theory for Interference management
6. Mr. R. Lakshminarayanan (Senior PhD scholar) – Robust Wiener Filters, Biased Estimators (has resigned on Sept.30, 2010)
7. Mr. Arun Ayyar (PhD scholar) – Robust LLR
8. Ms. S. Rajeshwari (MS scholar) – MBER based MIMO precoded AF 2-way Relays

9. IISc : Mr. Avinash Mohan (Proj. Assoc.) on Channel Truncation + Amit Dutta (PhD scholar) on MBER

10. IIT Kanpur: Umesh (PhD scholar) on Superposed training for OFDM and non-coherent CE
Significant Collaborative Activities (after Coleraine meeting)

1. Sept. 2010: Prof. KVS Hari from IISc visited IIT-M during for project discussion
   - This work, on OFDM channel truncation, will be used in defining contribution to LTE-A where a mixture of large CP and short CP sub-frames can be used within a frame to enable spectrally efficient deployment in large rural cells

2. Dec. 2010: Telecon between IITM and IISc on channel models and simulation assumptions

3. Jan. 2011: Telecon between UK and India partners

4. Jan. 2011: Between Theme 5 (Dr. Karthik) and Theme 7 (Dr. Sheetal, Dr. Giridhar) there has been interaction on the topic of “channel aware scheduling”; work has been submitted to IEEE journal on Wireless Comm. (please see [9]). Can also work with Theme 9 on this topic.

5. One of the algorithms being developed in Theme7 (OFDM channel truncation for large delay spreads) is being ported by a Master’s student to the hardware being developed as part of the 4G testbed in Theme10.
   - Other algorithms from Theme 7, such as enhanced channel estimation, robust LLR estimation, etc, will also be implemented on the 4G testbed in the 2nd phase.
Planned Activities in 2011

- **Strengthen inter-theme co-operation**
  - Work with theme 10 on algorithms for testbed
  - Work with theme 5 and theme 9 on scheduling/resource allocation

- **Interested in bringing in Tata Elxsi as new industry partner to WP7**
  - Collaboration with U.Southampton on robust channel estimation is planned

- **Additional faculty invited to be part of Theme 7**
  - Aditya Jagannatham (IITK) – Multicast video transmission for OFDM cellular
  - Arun Pachaikannu (IITM) – OFDM PHY layer algorithms
  - R. Venkatesh (IITM) – Scheduling & Resource Allocation, Co-op: Scheduling
Planned Activities in 2011 – contd. 1

- **Pulling in all partners within theme7 is also important**
  - Good traction between IISc and IITM on channel truncation
  - Will start collaboration with IITK this year; restart with Sasken
  - U. Southampton is working with BT

- **Get lock-in on specific topics for collaboration with UK partners**
  - U. Southampton has got first collaborative paper with IITM (in WCNC-2011); other research topics for collaboration include
    - 1. MIMO Precoding for 2-phase relays (Ms. Rajeshwari, IITM)
    - 2. Network coding with interference processing (Ms. Bama, IITM)
    - 3. MBER based symbol decoder for MIMO-OFDM (Ms. Vaishnavi, IITM)
    - 4. MBER based channel estimation and decoding (Amit Datta, IISc)
  - U. Southampton and IITK collaboration on non-coherent estimation
  - Start interaction with U. Surrey
    - Mehrdad at U. Surrey and Venkatesh of IITM – e.g. Co-operative Scheduling (Ms. Bahareh, U. Surrey)

- **Visits by IITM researchers to Southampton – possibly in Spring 2011**
India-Partners : Visible Research Output (in the last 6 months)


India-Partners -- Visible Research Output (in the previous 6 months)


UK-Partners -- Visible Research Output (over the past 18 months)


UK-Partners -- Visible Research Output contd.2


- L. Wang, L. Hanzo: Multiple-Symbol Differential Sphere Detection for the Amplify-and-Forward Cooperative Uplink, IEEE VTC’09 Fall, 20-23 September, Anchorage, Alaska, USA.

- L. Wang, L. Hanzo: Multiple-Symbol Differential Sphere Detection for the Amplify-and-Forward Cooperative Uplink, VTC’09 Fall. 20-23 September, Anchorage, Alaska, USA.

UK-Partners -- Visible Research Output contd.3

- L. Wang, L. Kong, S.X. Ng, L. Hanzo: To Cooperate or Not: A Capacity Perspective, VTC 2010 Spring, Taipei, Taiwan, May 2010

- L. Wang, L-K. Kong, S-X. Ng, L. Hanzo: A Near-Capacity Differentially Encoded Non-Coherent Adaptive Multiple-Symbol-Detection Aided Three-Stage Coded Scheme, VTC 2010 Spring, Taipei, Taiwan, May 2010


- Rong Zhang; Xinyi Xu; Hanzo, L.: Co-Channel Interference Mitigation Capability of Fixed Relays Connected by Optical Fibre, IEEE 72nd Vehicular Technology Conference Fall (VTC 2010-Fall), 2010

- Rong Zhang; Hanzo, L.: Harmony Search Aided Iterative Channel Estimation, Multiuser Detection and Channel Decoding for DS-CDMA, IEEE 72nd Vehicular Technology Conference Fall (VTC 2010-Fall), 2010

- Rong Zhang; Hanzo, L.: Joint and Distributed Linear Precoding for Centralised and Decentralised Multicell Processing, IEEE 72nd Vehicular Technology Conference Fall (VTC 2010-Fall), 2010

- R. Zhang, L. Hanzo: Variable-Rate Network Coding for Multi-Source Cooperation, WCNC'2011, Cancun, Mexico, March 2011