# IC-037: Principles of diversity in wireless networks (former title : Role of diversity...)

Computer, Communication and Information Sciences

(Valid from 01.08.2006)

| Instructor | Diggavi Suhas | Frequency | Every 2 years |
|---|---|---|---|

| Program(s)/Acad.year | Total hours | Examination procedure | ECTS credits |
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| **Computer, Communication and Information Sciences (2006-2007)** | Lecture: 2 H hebdo<br>Recitation: 2 H hebdo | Multiple | 4 |

**Objectives:**

This is a doctoral school class with the focus on the impact of spatial diversity on various networking functionalities from physical layer transmission, to media access, resource allocation, as well as connection to applications. Spatial diversity encompasses the use of multiple transmit and receive antennas as well as protocols that use the presence of multiple independent users. Over the past decade there has been significant progress in methods to utilize spatial diversity in wireless networks. The goal of this class is to introduce this on-going research topics to students in the School of Computer and Communication Sciences. Here is a brief outline of the class.

**Content:**

1. Wireless channel: propagation effects
- Mobility and multipath fading: delay spread and Doppler spread.
- Multiple antenna (spatial) propagation models: angle spread.

2. Reliable transmission rates for fading channels
- Fast fading channels: receiver CSI, transmitter CSI.
- MIMO performance gains: linear rate growth, high SNR regime.
- Linear receiver structures: matched filter receiver, decorrelating receiver.

3. MIMO channels: diversity order and error probability
- Slowly fading channels: non-ergodic regime, outage probability.
- Diversity order and coding gain.
- Space-time code design criteria.

4. MIMO channels: rate-diversity trade-off
- Information theoretic diversity-multiplexing trade-off and degrees of freedom in MIMO channel.
- Alphabet constrained trade-off: fixed-rate versus diversity order trade-off.

5. MIMO channels: space-time codes
- Space-time block codes: orthogonal designs, linear codes, rotation codes.
- Non-coherent designs: differential codes.
- Rate-growth codes.

6. Scheduling and resource allocation
- Network functionalities and topologies.
- Hierarchical systems: Uplink and downlink rates.
- Multi-user diversity effects.
- Scheduling criteria and inputs: rate-based criteria, job-based criteria.
- Rate-based opportunistic scheduling.

7. Ad hoc networks
- Modeling: Throughput criteria, traffic models, channel models.
- Fixed random network: throughput scaling laws.
- Mobile random network: throughput scaling laws.
- Information-theoretic bounds.

**Required prior knowledge:**

Advanced Digital Communications, Information Theory, probability and random processes, linear algebra

**Form of examination:**

Written exam, project report and term paper

**Keywords:**

Wireless communication, Information theory, Error correcting codes, Resource allocation, Large scale networks