Chapter 1
Introduction : History of Channel Characterization and Modeling

Course scope

- Motivation
  - Characteristics of the propagation channel is of great importance
  - Fast-growing wireless communications pose more demanding on channel characteristics
- Content of the course
  - Fundamentals for both empirical measurement-based and theoretical scattering-based channel modeling
  - Updated channel models that can be practically used for simulations
  - Highlights the on-going trends with some fresh research results

Importance of channel characterization

- Application of statistical characteristics of the channels in system design
  - path loss model
  - shadowing models
  - multipath fading models
  - delay spread models
  - Doppler frequency spread models
  - cluster-based bidirectional models
- Usage of instantaneous knowledge of the channel
  - Equalization during communications
  - Channel maps for deterministic channel playback
  - Fingerprinting for localization

SISO channel models

- Fading in frequency (FDMA), 1968 Okumura
- Fading in outdoor region, 1977 Suzuki
- SISO in indoor propagation environments, 1987 Saleh
- Discrete models, 1975 Cox
- Indoor manufacturing environments, 1991 Yegani
- Delay and Doppler domain, 1973 Cox
- Polarization characteristics of channel, 1970 Lee, 2001 Andrews

Spatial channel models

- DoA problems, 1970's
- MIMO, 1990's
- Geometry-based channel modeling (GBSM), 1990's
- Spatial-spectral analysis methods
  - Periodogra, Schuster1898
  - Correlogram, Chatfield1989
  - Subspace-based method, Paulraj1986
  - Expectation-maximization (EM) algorithm, Moon97, Frenkel1999
  - Space-alternating generalized expectation-maximization (SAGE) algorithm FeHe94, FlTs-99
- 3GPP TR 25.996 models, 2007
- WINNER II spatial channel model-enhanced (SCME), 2009
- ITU IMT-Advanced models, 2010
- COST 2100 models, 2012
- ...

Other channel models

- Multi-link channel model
- Distributed channel model
- Relay channel model
- Non-stationary channel model
- Reciprocity channels model
- Massive MIMO model