

Introduction of Propagation Lab

<http://www.ap.ide.titech.ac.jp/>



Propagation Lab

- Department of International Development Engineering
 - NOT EECS group
 - Social and economic development through technology
- Members of Lab
 - Prof. Jun-ichi Takada
 - Asst Prof. Minseok Kim
 - 9 doctoral candidates (including 3 part time)
 - 6 master candidates
 - 3 undergraduates
 - 1 research student
 - 1 office assistant
 - 60% of members from abroad

Study Areas

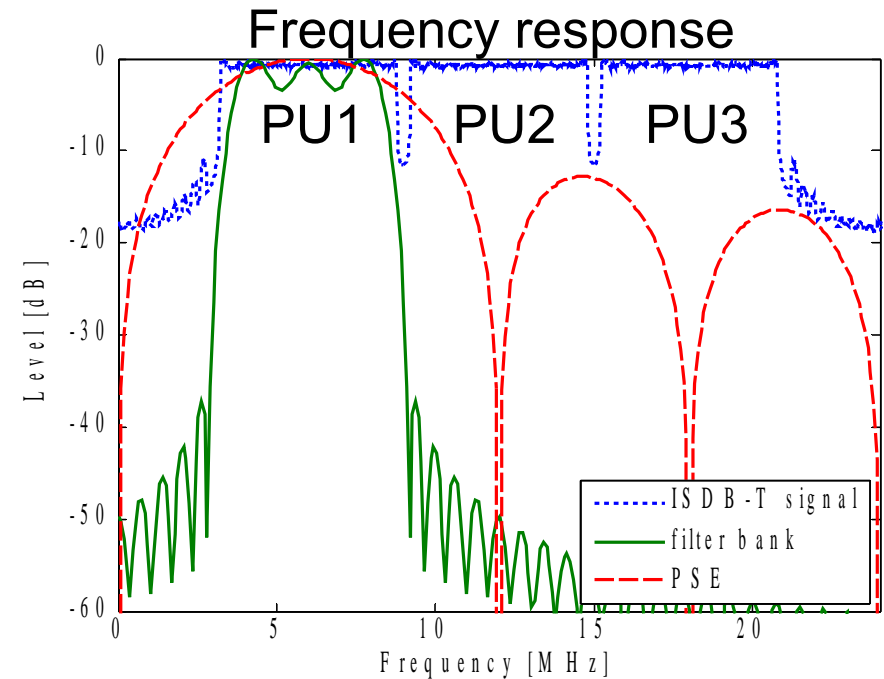
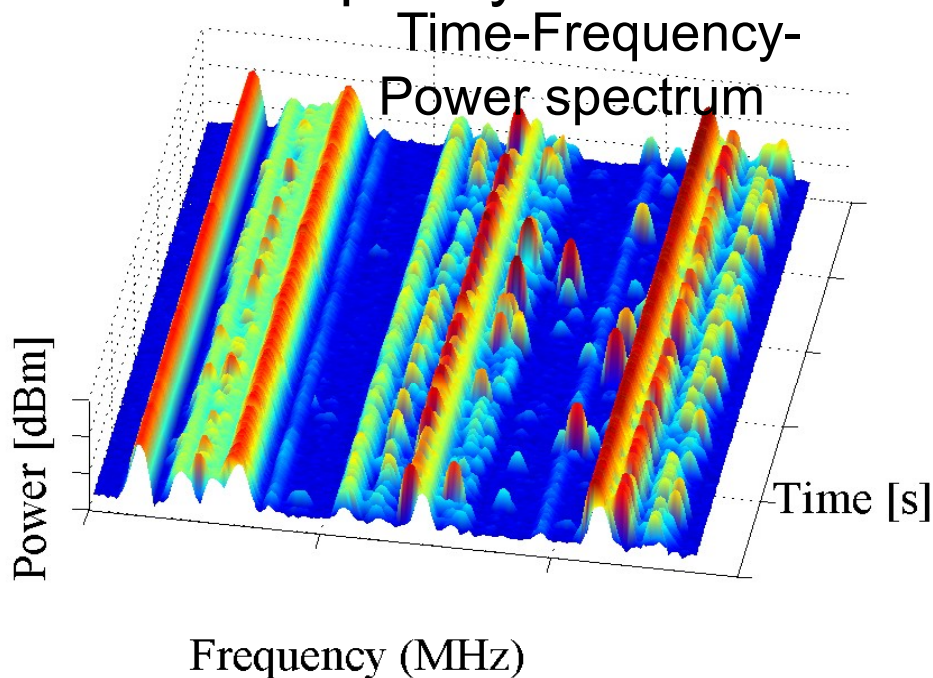
- Propagation and channel characterization for wireless communications
 - Measurement and simulation
 - Emphasis on double-directional approach
 - Application of spherical harmonics
 - Macrocell, microcell, short range, body area, etc.
- Fundamentals on cognitive radio
 - Detection and sensing
 - Testbed implementation
- Others
 - Evaluation and test of terminal array antennas in multipath environment
 - Application of ICT in world heritage site in Lao PDR

Recent Progress

- Spectrum Sensing Technique using Polyphase DFT Filter Bank for Opportunistic Cognitive Radios (Minseok Kim)
- GNU Radio Sounder (Mutsa Gahadza)
- Body Area Network Channel Measurement and Modeling (Yuuki Terao)
- Spatio-temporal Multipath Clustering of an Estimated Wideband MIMO Channel at the Mobile Station (Lawrence Materum)
- Ultra Wide Band (UWB) Delay Estimation (Dashti Marzieh)
- Principal Propagation Mechanisms in the Urban Macrocell Channel at 2.2 GHz (Mir Ghoraishi)

Spectrum Sensing Technique using Polyphase DFT Filter Bank for Opportunistic Cognitive Radios

- To utilize white space agilely, wide range of spectrum should be simultaneously monitored as frequently as possible.
- Filter bank can provide efficient bandpass filter implementation with low spectrum power leakage (good false alarm performance).
- This work proposes a framework of multi-channel sensing architecture based on poly-phase DFT filter bank followed by energy detector with minimum complexity.



Body Area Network Channel Measurement and Modeling

So far, it was difficult to take the dynamic channel behavior with Network analyzer. Because the dynamic channel behavior for BAN standard with network analyzer needs very fast sweep time.

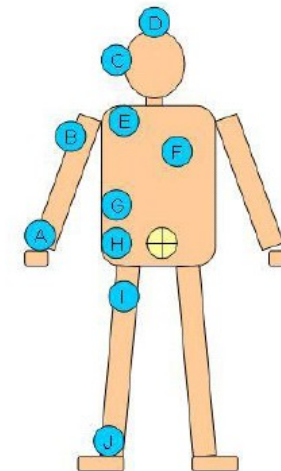
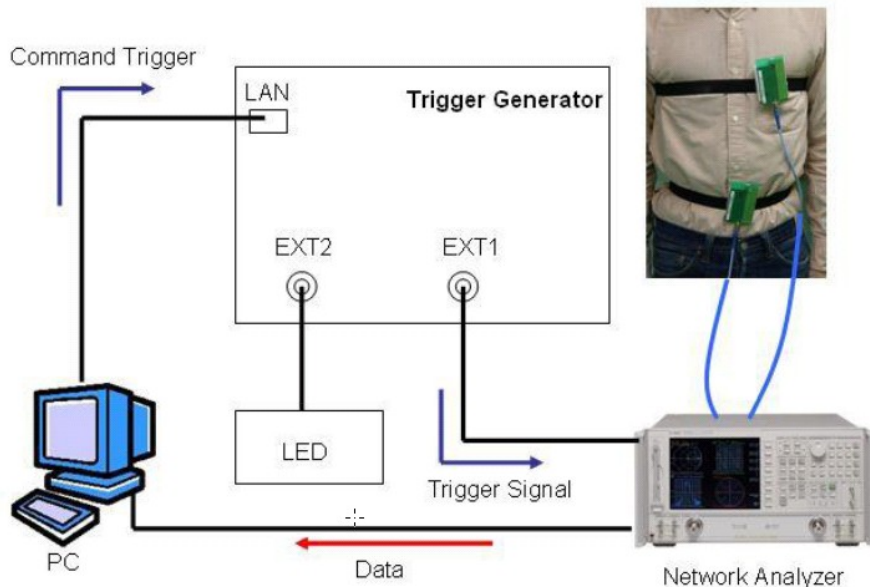
	Previous experiment	New experiment
equipment	a real-time channel sounder	network analyzer
frequency	4.5GHz z	444.5MHz, 611MHz, 953MHz
frequency band	120MHz	Zero span mode

For narrow band transmission



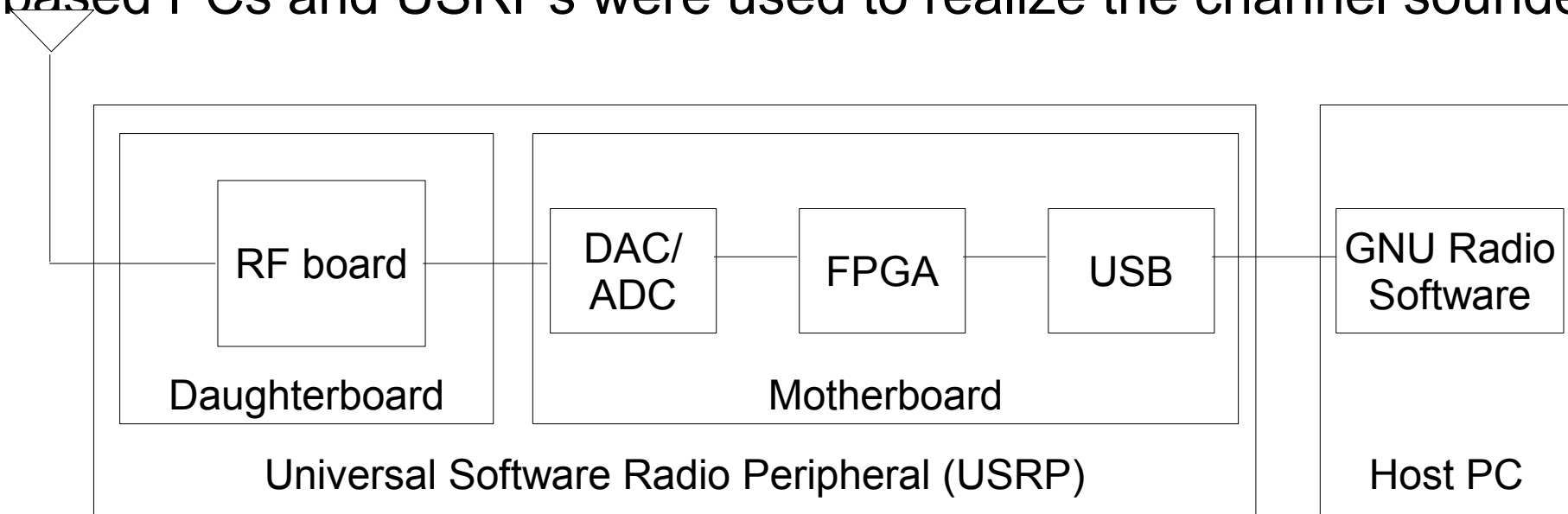
Frequency band
400 MHz
600 MHz
900 MHz
2400 MHz
UWB

It is enough for using the zero span mode(narrow band transmission)



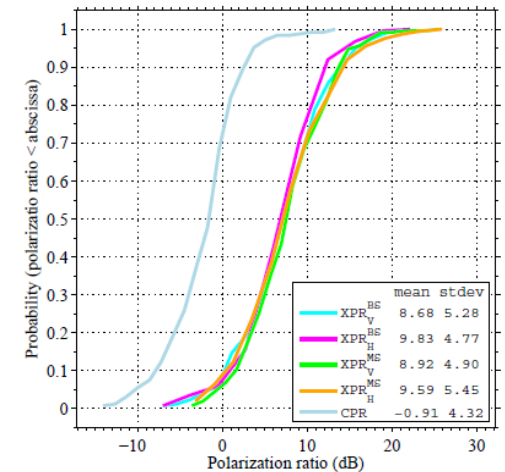
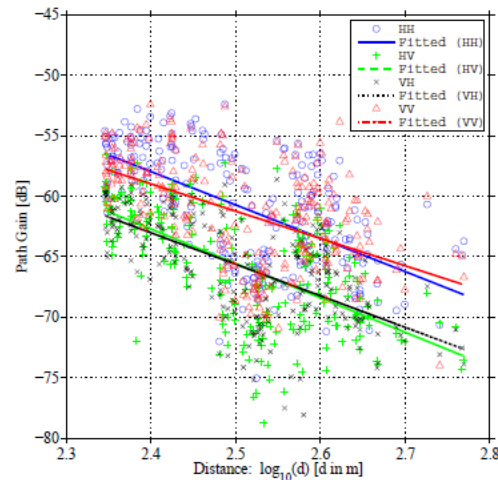
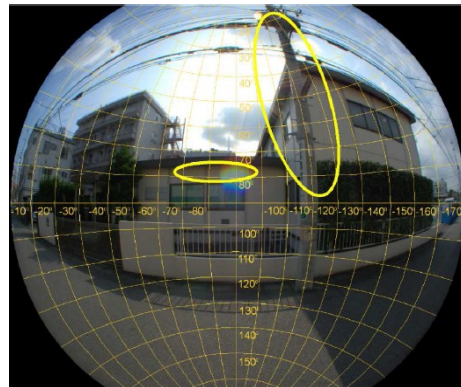
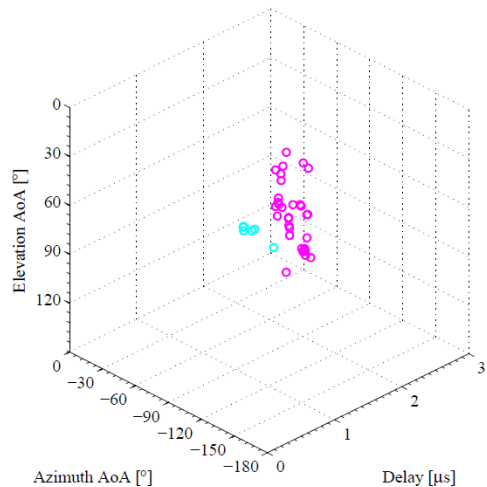
Implementing a PN sequence based channel sounder using GNU Radio

GNU Radio refers to some open source software platform which, together with some low costs hardware called USRP(Universal Software Radio Peripheral) , can be used to realize software defined radios (SDR). While aware of the possible limitations inherent to this technology, this research seeks to explore the suitability of the GNU Radio platform in the realization of a PN(Pseudo Noise) based channel sounding system. Two Linux based PCs and USRPs were used to realize the channel sounder.



Spatio-temporal Multipath Clusterization of a MIMO Channel Estimates *and* Cluster Polarization Characterization

- Identification of multipath clusters in a better way—globally optimized automatic clustering approach & successive manual clustering verification
- Emphasis on the physical meaning of clusters
- Cluster XPR were verified as log-normally distributed but not true for cluster CPR, and HH pairs decayed faster than their VV counterparts. Polarization ratios were found to be affected by elevation AoA.

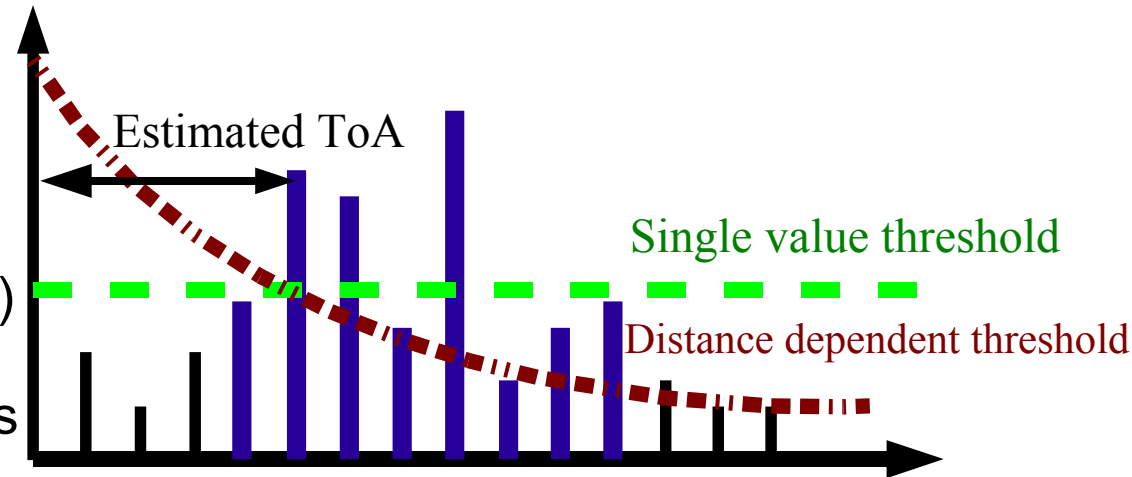


Ultra wide band (UWB) Delay Estimation

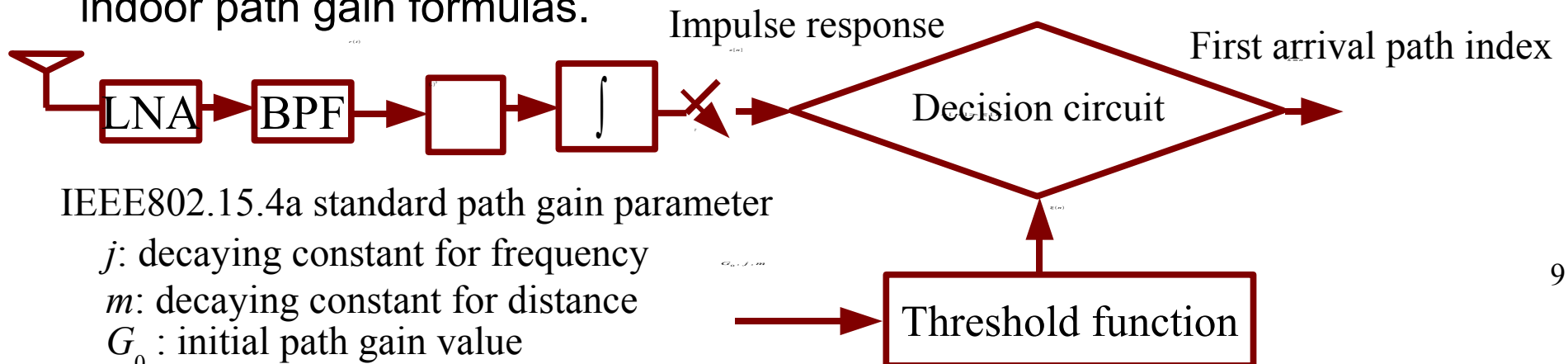
- Several schemes have been reported for time of arrival (ToA) estimation, among these schemes, the threshold-based ToA estimation has attracted interest due to its simplicity of its hardware implementation.
- In threshold-based ToA estimation, samples can be compared to an appropriate threshold.

- In the conventional threshold based methods, a single threshold value is used to estimate the ToA.

We introduce a distance dependent(DD) threshold, which is postulated on the fact that power of FAP decreases as Tx-Rx distance increases.



- A reasonable criterion for obtaining the DD threshold function is the path gain. DD threshold approach can be made generic by employing standard indoor path gain formulas.



IEEE802.15.4a standard path gain parameter

j : decaying constant for frequency

m : decaying constant for distance

G_0 : initial path gain value

Principal Propagation Mechanisms in the Urban Macrocell Channel at 2.2 GHz

- The three principal propagation mechanisms in the urban mobile channel are confirmed dominant in the copolar channel
- Analysis in 3 dimensions reveals that strong BS-direction and opposite BS-direction include more than one reflection/diffraction occurrence in the channel
- In the perpendicular streets, the strongest mechanism can be the **BS-direction** path which has endeavored **two reflections**

