Real-Time Testbed for Simultaneous Powerline and Wireless Smart Grid Communications

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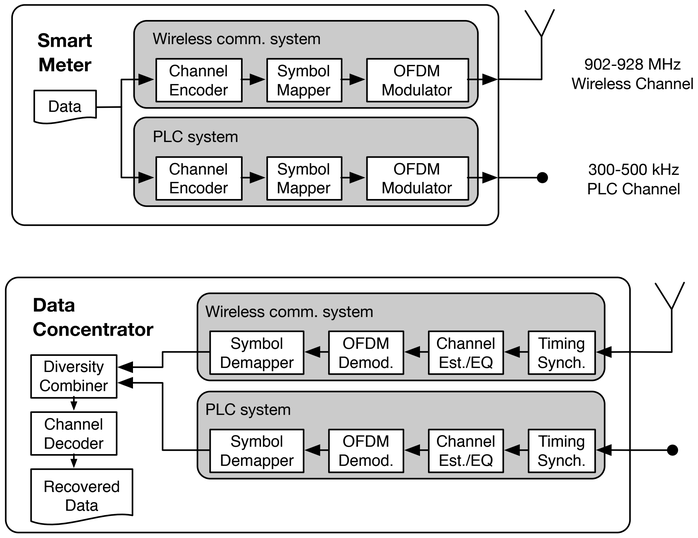
Motivation

I



In smart grid communication
- Two-way communication is a key feature
- Smart meter and data concentrator exchange information
- Either powerline or wireless communications is employed

Simultaneous use of powerline and wireless communications
- can enhance communication reliability
- requires diversity combining schemes
- has been theoretically studied

Question

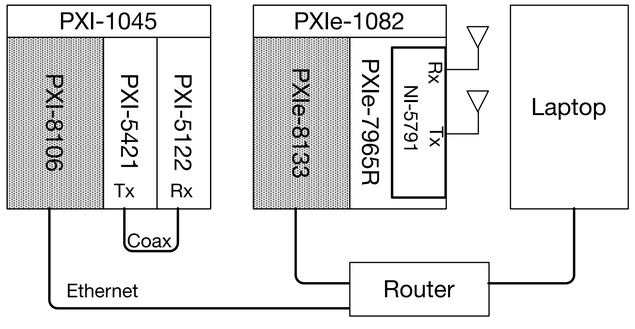
Will it work in an actual deployment? If so, how good?

Answer

Real-time testbed needs to be implemented

Hardware Architecture

II



Real-time Systems
- Signal Tx/Rx
- Baseband processing

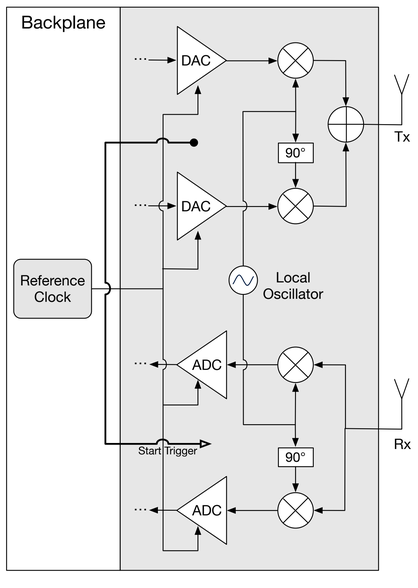
Desktop / Laptop
- Main controller
- Monitoring

Chassis #1
- PLC link
  Flat-fading
  No interference
  Thermal/quant. noise
- Sends soft bits to #1

Chassis #2
- Wireless link
  Flat-fading (LOS)
  No interference
  Thermal/quant. noise
- Average SNR MRC
- Has control over #2

Synchronization

III



Sample clock synchronization
- prevents sample clocks from drifting away
- ADC/DAC clocks are PLL'd to reference clock

Transmitter/Receiver synchronization
- ensures both Tx and Rx start simultaneously
- Transmitter sends start trigger to Rx

LO synchronization
- removes carrier frequency offset
- Single LO is used by both upconverter and downconverter

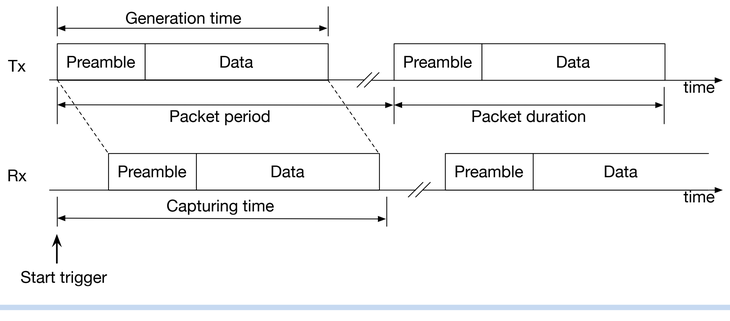
Packet synchronization
- prevents memory overflow
- Real-time OS guarantees packet transmission timing of both systems

Sample timing synchronization
- detects packet and FFT window boundaries
- Preamble in a packet is used

Common System Parameters

IV

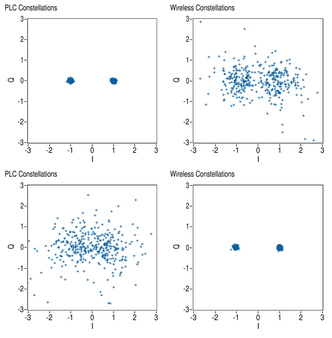
Parameter	Value
Sample rate	400 kHz
OFDM size	256
CP length	64
Packet duration	variable
Number of data subcarriers	36
Data modulation	BPSK only



Initial Results

V

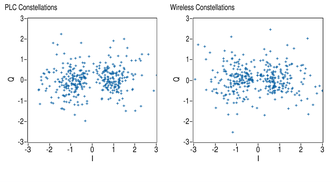
One link with a low E_b/N_0



	PLC	Wireless	Combiner
E_b/N_0	26.9 dB	5.38 dB	N/A
BER	0	2.65×10^{-2}	0

	PLC	Wireless	Combiner
E_b/N_0	5.06 dB	27.4 dB	N/A
BER	3.33×10^{-2}	0	0

Two links with low E_b/N_0



	PLC	Wireless	Combiner
E_b/N_0	6.98 dB	7.15 dB	N/A
BER	3.61×10^{-2}	4.14×10^{-2}	1.77×10^{-3}

Software Release
http://users.ece.utexas.edu/~bevans/projects/plc/software/testbed/

The University of Texas at Austin
Electrical and Computer Engineering
Cockrell School of Engineering

Wireless Networking & Communications Group

Embedded Signal Processing Laboratory
The University of Texas at Austin

Project supported by
Texas Instruments
NXP