Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Transmission power control for ULP]
Date Submitted: [November 4th, 2013]
Source: [Weidong Gao, Jingwen Liu, Zhe Chen]
Company [Potevio]
Address [No.6 Haidian North Second Street, Haidian District, Beijing 100080, China]
Voice:[+86-10-82484642]
FAX: [+86-10-62683797]
E-Mail:[gaoweidong@cpit.com.cn]
Re: [In response to TG4q Call for proposals]
Abstract: [This contribution proposes power control to reduce transmission power.]

Transmission power control for ULP

November, 2013

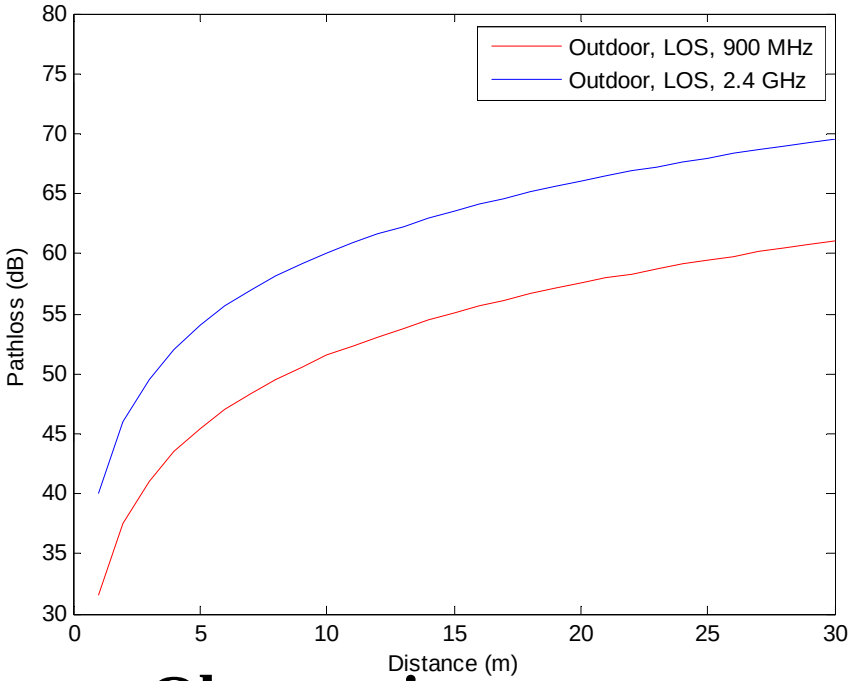
Weidong Gao, Potevio

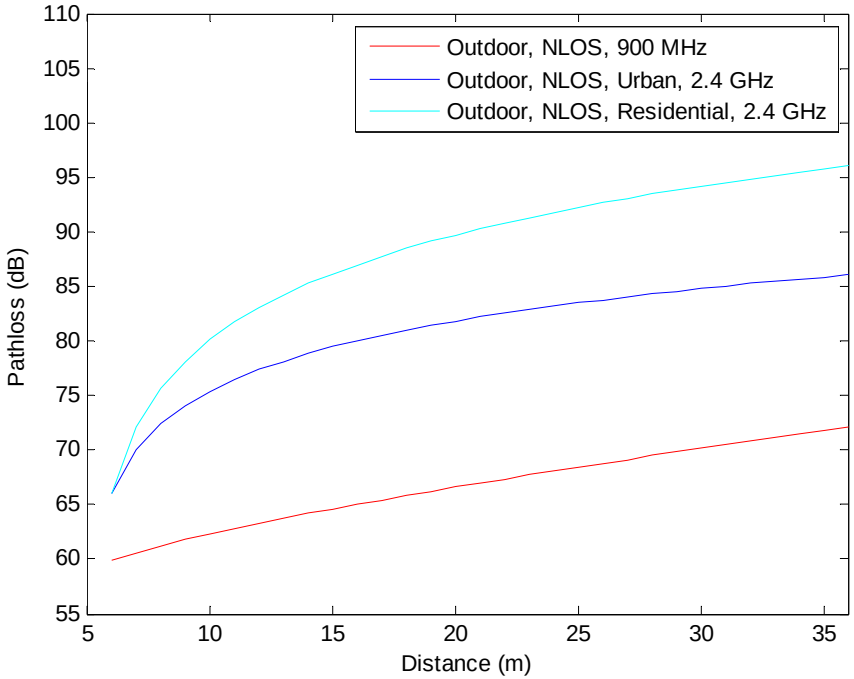
Abstract

- **This contribution proposes transmission power control for TG4q ULP.**

Review of TG4q Channel Models

- **Large Scale Fading-Outdoor, LOS & NLOS [1]**

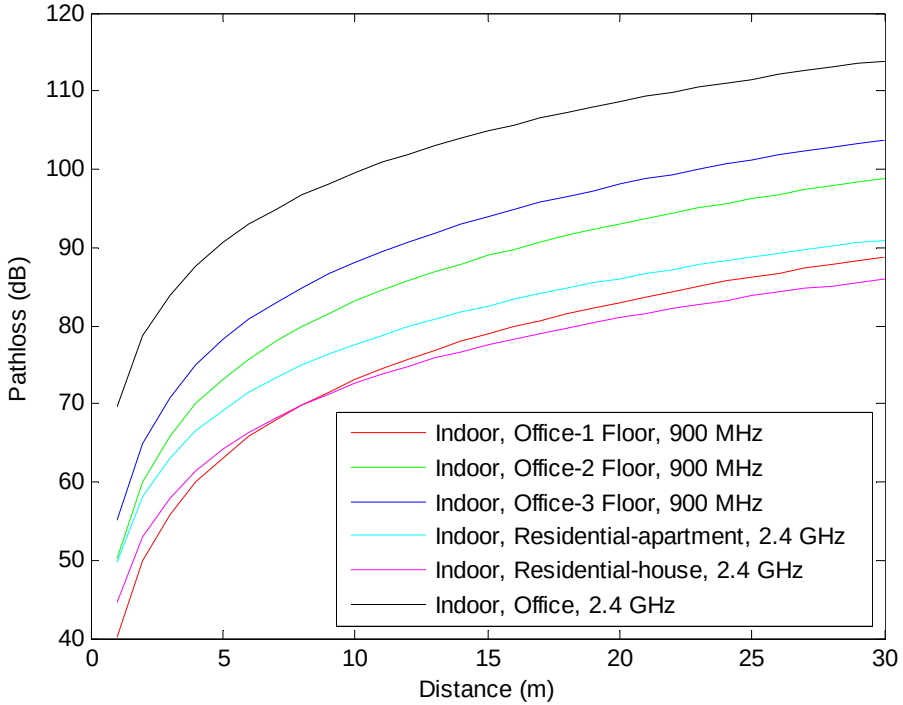




- **Observation**
  - There is distinct variation for outdoor large scale fading within 0-30m range .

Review of TG4q Channel Models

- **Large Scale Fading-Indoor [1]**



- **Observation**
  - There is distinct variation for indoor large scale fading within 0-30m range .

Review of TG4q Channel Models

- **Coherence time [2]:** $T_C \simeq \frac{0.423}{f_d} = \frac{0.423}{vf/c}$
  - 170ms (900 MHz), 63ms (2.4 GHz)
- **Packet interval**

$$T = T_{Data} + T_{Ack} + 2IFS + 2\tau$$

  - Data transmission time: 5.44 ms (170 Byte, 250 kb/s)
  - Ack frame transmission time: 0.16 ms (5 Byte, 250 kb/s)
  - Interframe space: 0.64 ms (O-QPSK, 62.5 ksymbol/s)
  - Propagation time: 0.0001 ms (30 m)
- **Observation**
  - At most 24 (900 MHz), 9 (2.4 GHz) data frames can be accommodated within single coherence time

Review of TG4q ULP applications [3]

Market Sector	Data Rate (Kbps)	Range (m)	Number of Nodes	Reliability	Form Factor	Duty Cycle	Payload Size	Mobility	Battery Life
Smart Utility (Gas/Water)	100	30	1000s	High	--	Low	Small	No	Years
Building Automation	1000	30	100s	High	S, M	Mid	Mid	No	Years
Medical / Health Care	1000	10	10s	High	Small	High	Small-Mid	Yes	Days-Mos
Retail Service	100	30	100s	High	Small	Mid-High	Mid-Large	Yes	Years
Telecom Service	1000	10	10s	High	Small	High	Mid-Large	Yes	Days
Industrial Monitoring	100	100	100s	High	--	Mid-High	Small-Mid	No	Years
Environment Monitoring	100	100	100s	High	--	Low	Small	No	Years
Inventory Tracking	100	100	1000s	High	Small	Low	Small-Mid	Yes	Years
Energy-Harvesting Sensor	100	10	10s	Low	--	Low	Small	--	Years
Smart Active Label	100	30	1000s	High	Small	Low	Small	Yes	Days-Mos
Shelf Label	1000	30	1000s	High	--	Low	Mid-Large	No	Months

Demand for Power Control

- **Strong demand**
  - Applications (3) : Medical / Health Care , Telecom Service, Energy-Harvesting Sensor
  - Characteristics: (Mobility & High duty cycle & Short battery Life) || Energy-Harvesting
- **Medium demand**
  - Applications (4) : Retail Service, Industrial Monitoring, Inventory Tracking, Smart Active Label
  - Characteristics: Mobility || High duty cycle || Short battery Life
- **Weak demand**
  - Applications (4) : Smart Utility (Gas/Water), Building Automation, Environment Monitoring, Shelf Label
  - Characteristics: Fixed & Low duty cycle & Long battery Life

Usefulness of Power Control

- **Power Control can be used to**
  - Compensate for large scale fading variety caused by distance variation
  - Compensate for slow fading from shadowing effect
  - Compensate for time-selective fading due to mobility

Potential Power Control schemes

- **Open loop Power Control**
  - A device estimates its transmission power levels according to the received signal strength from the communicating device
  - Merits: Simple, low complexity, less overhead
  - Drawbacks: Not suitable for one-way communication
- **Close loop Power Control**
  - A device resets its transmission power after receiving Transmission Power Control Command (TPC) from the communicating device
  - Merits: Accurate
  - Drawbacks: Larger latency, more overhead
- **Requirement of Power Control for ULP**
  - Simple, light-weight, less overhead (e.g piggybacked with Ack)

Conclusion

- Large scale fading of TG4q channel exhibits significant volatility within 3-30m range
- Multiple data frames can be accommodated within single coherence time
- Transmission Power Control is needed for a various of applications, i.e. Medical / Health Care, Telecom Service and Energy-Harvesting Sensor
- Propose TG4q to introduce transmission Power Control scheme and further study the details

Reference

[1] 15-13-0329-01-004q-channel-models-for-ieee-802-15-4q-draft

[2] T. Rappaport, “Wireless Communications: Principles and Practice” Pearson Education, 2nd Edition, 2002

[3] 15-13-0478-00-004q-ulp-application-summary