ISCAS 2010 Special Session

Recent Advances in IR-UWB Transceivers

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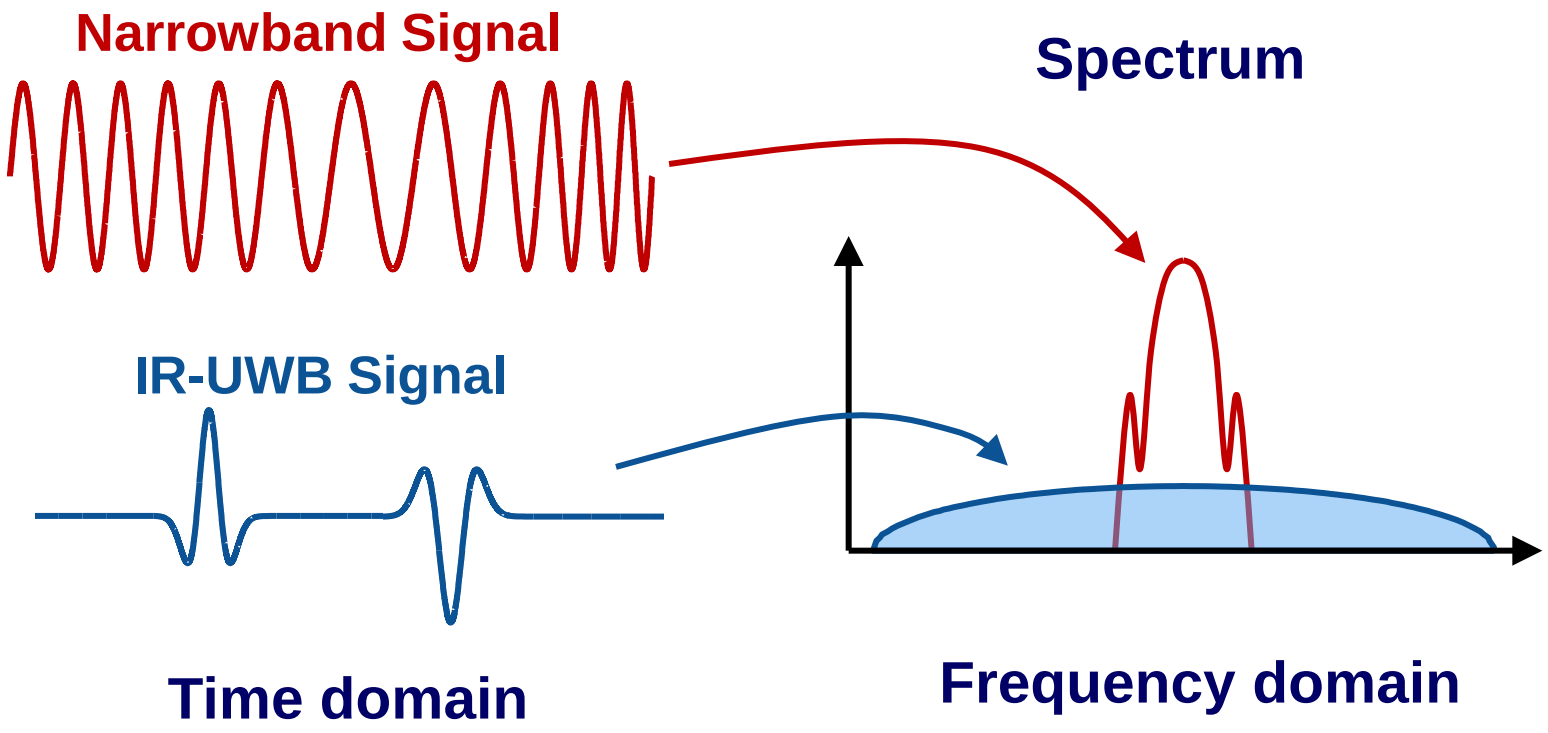
MichiganEngineering

Introduction to Impulse-Radio UWB

- **US/FCC defined UWB in 2002 as:**
  - **Fractional bandwidth > 20% … or …**
  - **–10dB Bandwidth > 500MHz**

$$FB = \frac{\text{Bandwidth}}{\text{Center Freq.}}$$

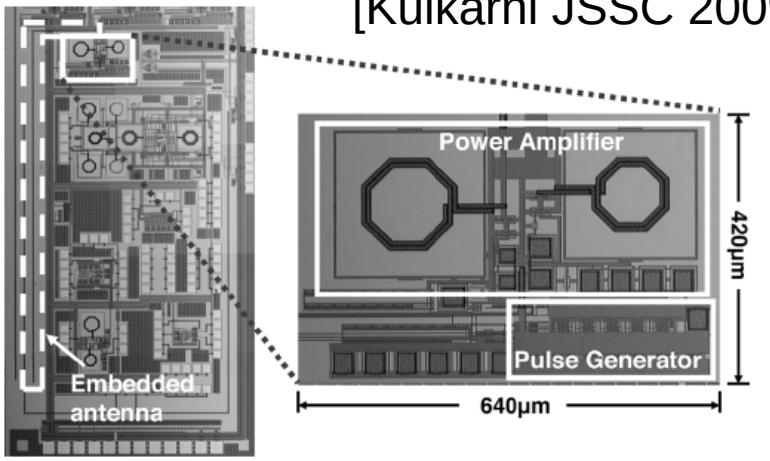
GSM e.g. FB = 0.02%



Advantages

- **High level of integration**
  - Antenna and electronics integrated
- **Ultra-low power**
  - Energy / bit ≈ 10pJ to 1nJ
  - 12.8pJ [Liu VLSI 2009]

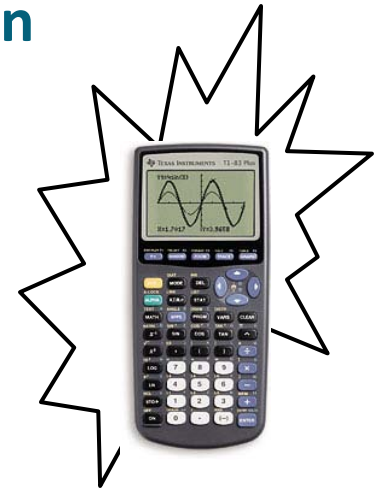
[Kulkarni JSSC 2009]

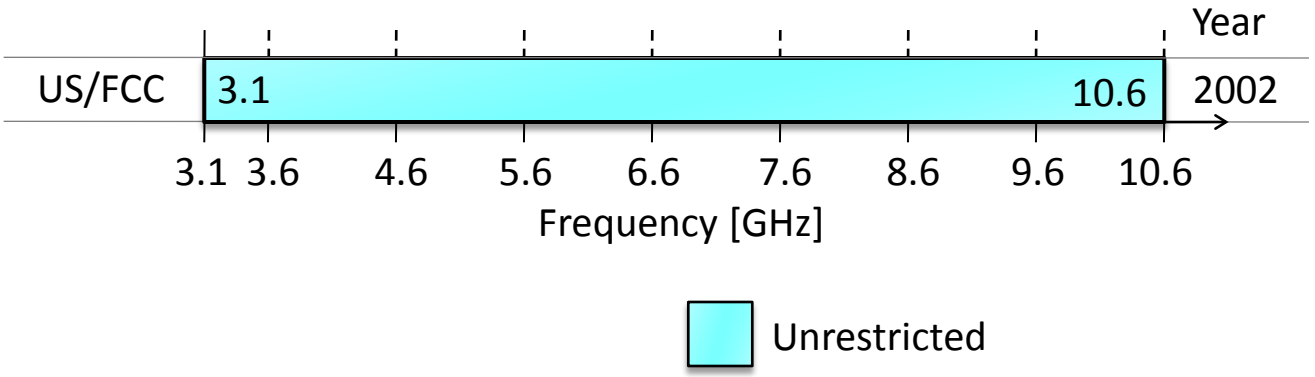


- **High data rates (streaming video >20Mb/s)**
  - 10kb/s to 2.5Gb/s
  - 2.5Gb/s [Juntunen *et al.* IMS 2009]
- **Precise positioning (RFID tagging)**
  - 3cm to 1m position accuracy

Regulations (*circa* 2002)

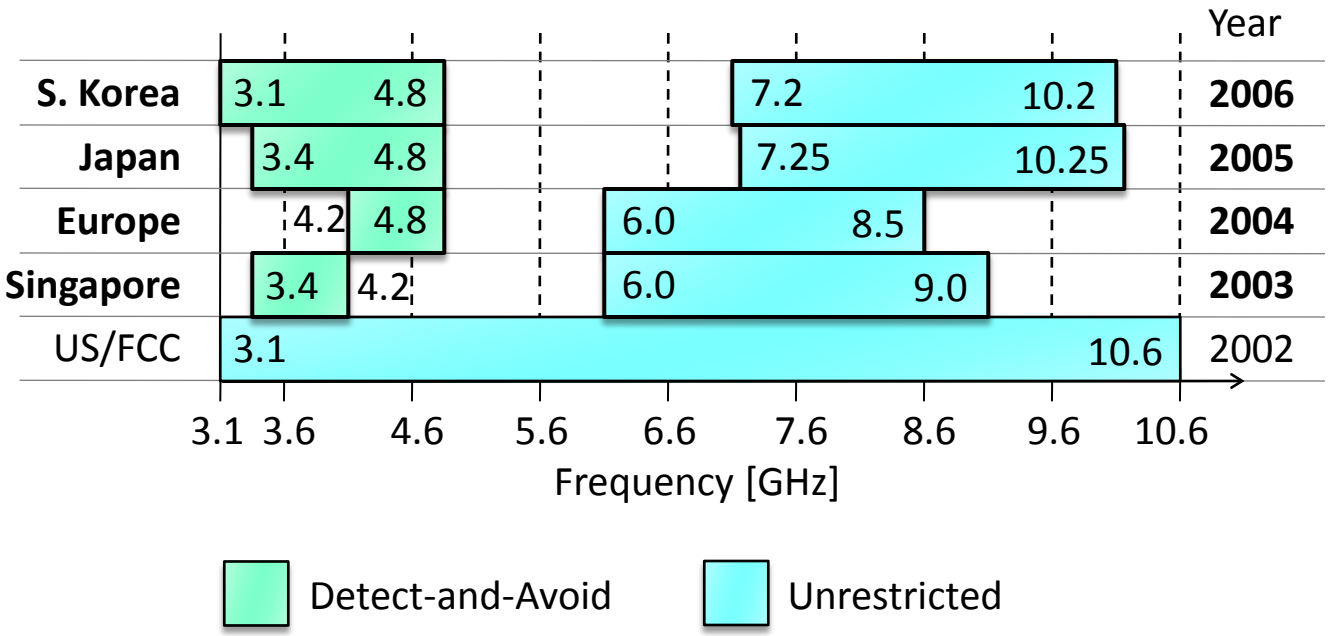
- **US/FCC opened two bands for UWB**
  - **0 – 960MHz for imaging, ground penetration**
  - **3.1 – 10.6GHz for communication**
- **Low transmit power density**
  - **–41.3dBm/MHz – same level as noise emissions for electronics**
  - **UWB "reuses the noise floor"**





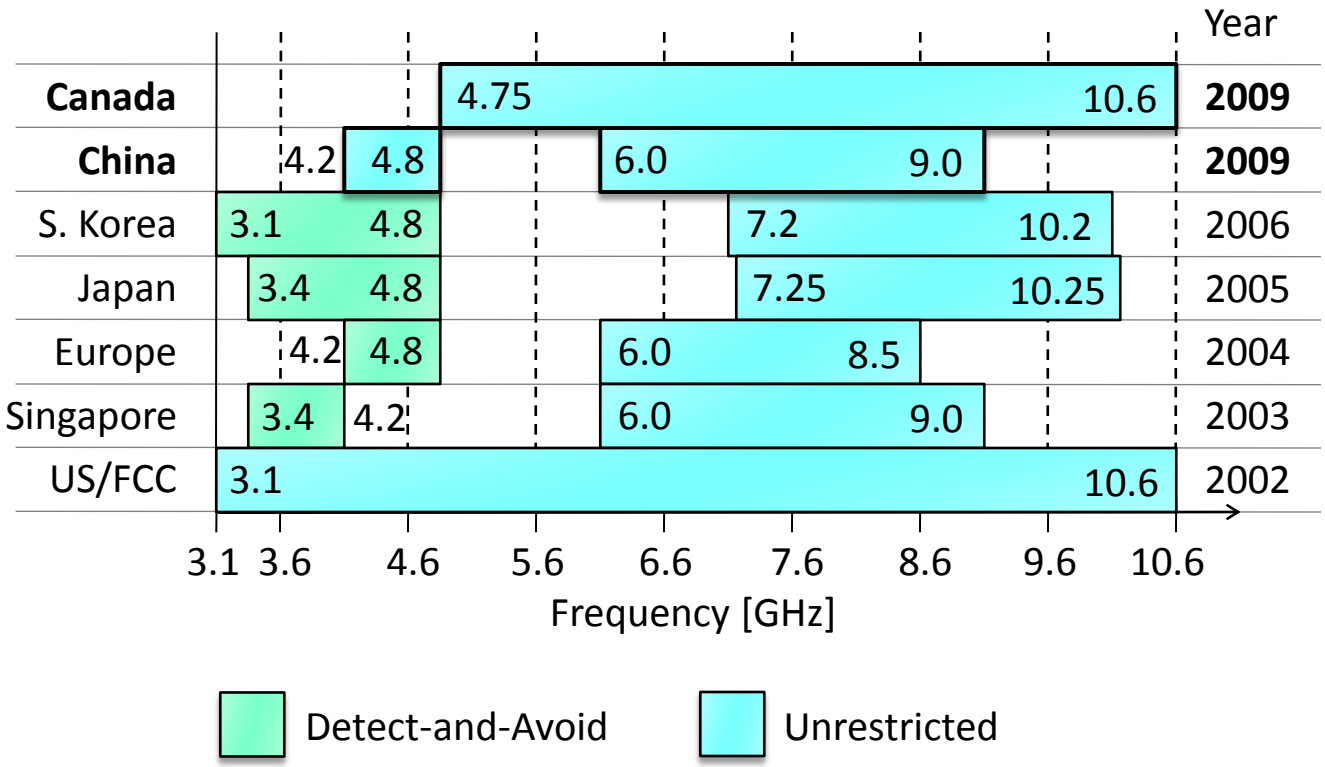
Regulations (*circa* 2006)

- **Rapid adoption by others**
- **Detect-and-avoid or time restrictions in lower bands**
  - **DAA: sense in-band before transmitting**



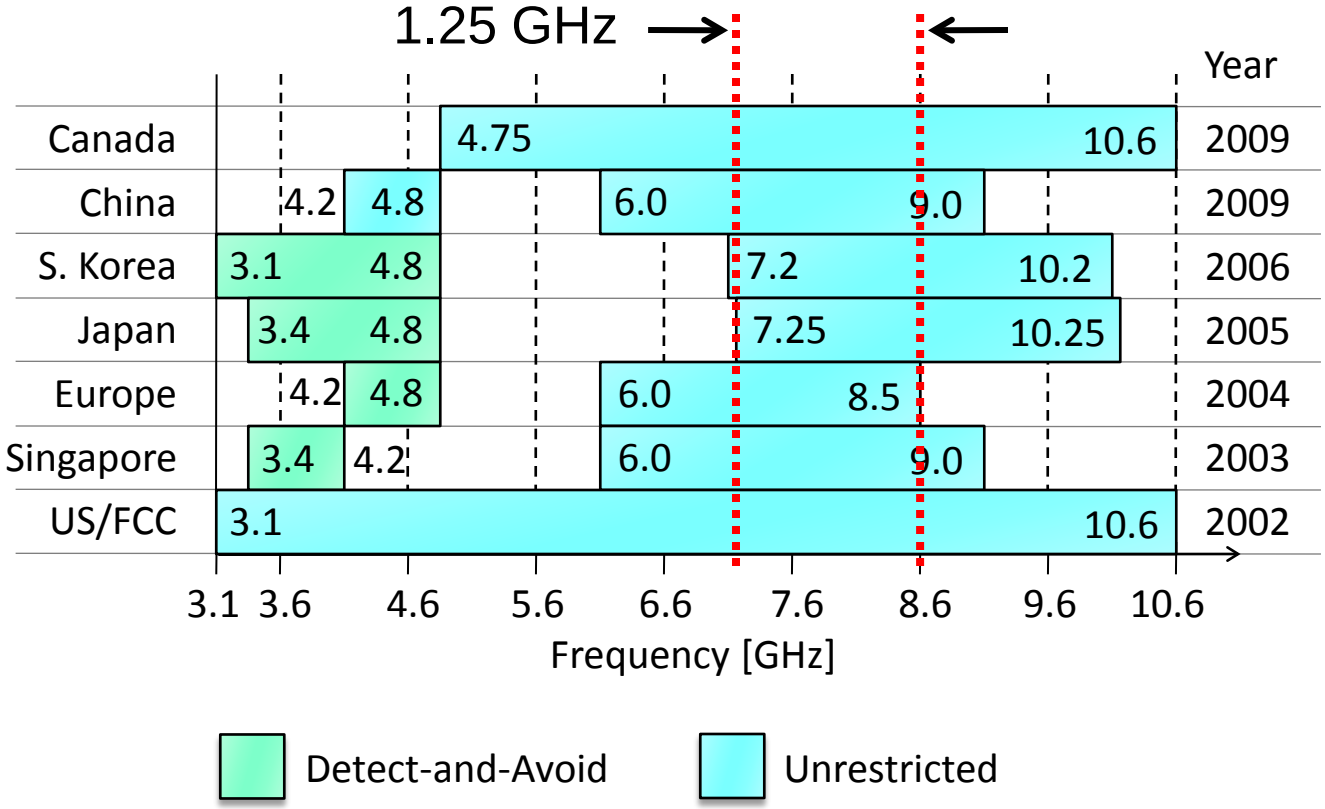
Regulations (Current)

- **Canada & China adoption in 2009**

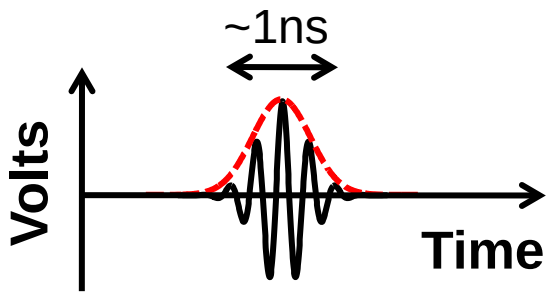


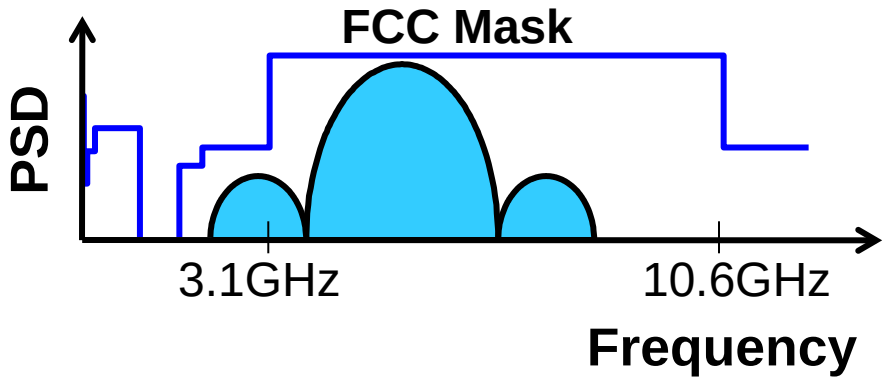
Regulations (Current)

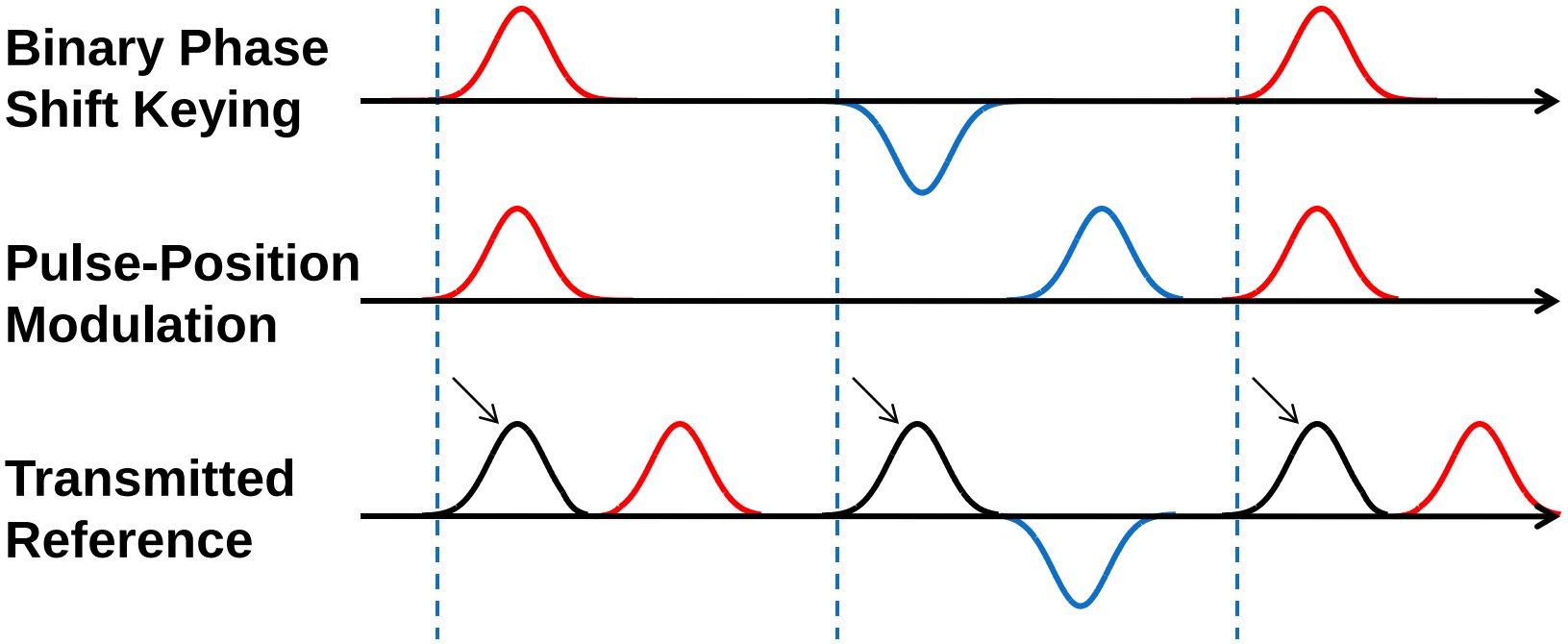
- **International bandwidth: 7.25 to 8.5GHz**
- **Total average EIRP: 92µW (–10dBm)**



IR-UWB Signaling



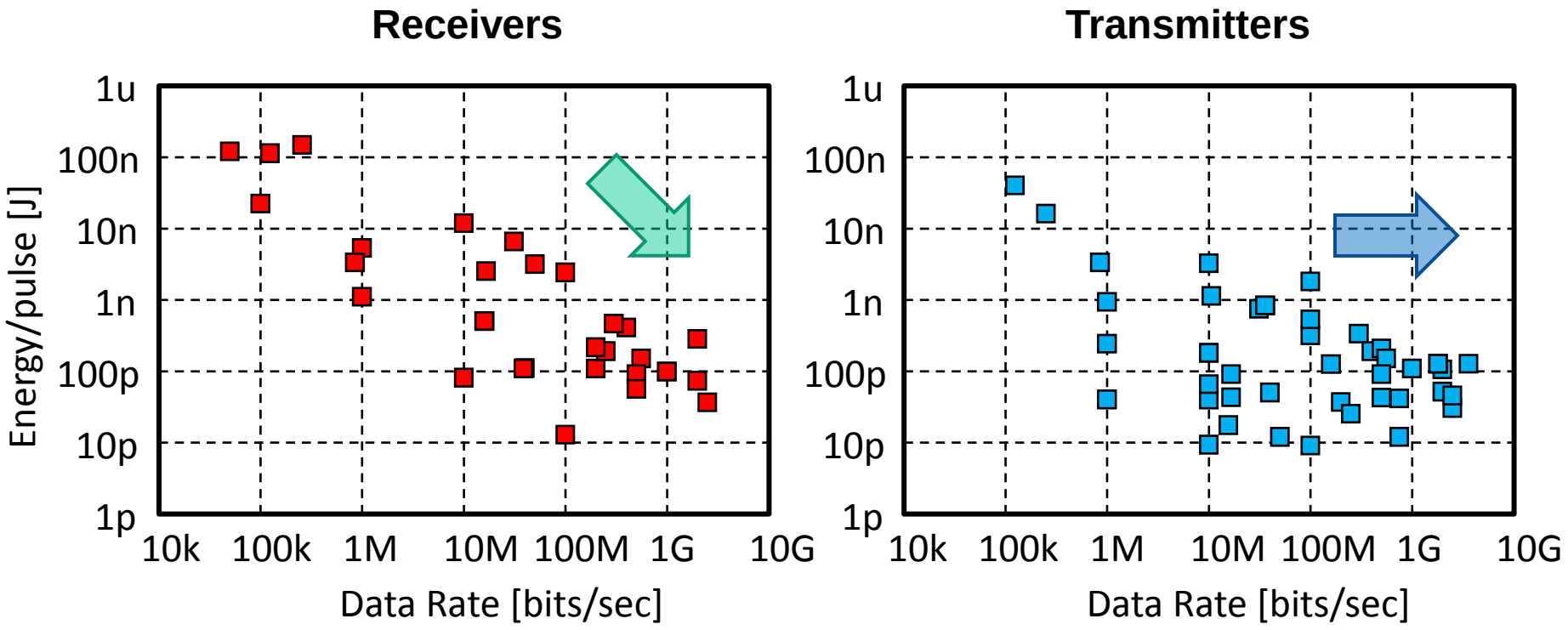




Standards Activity

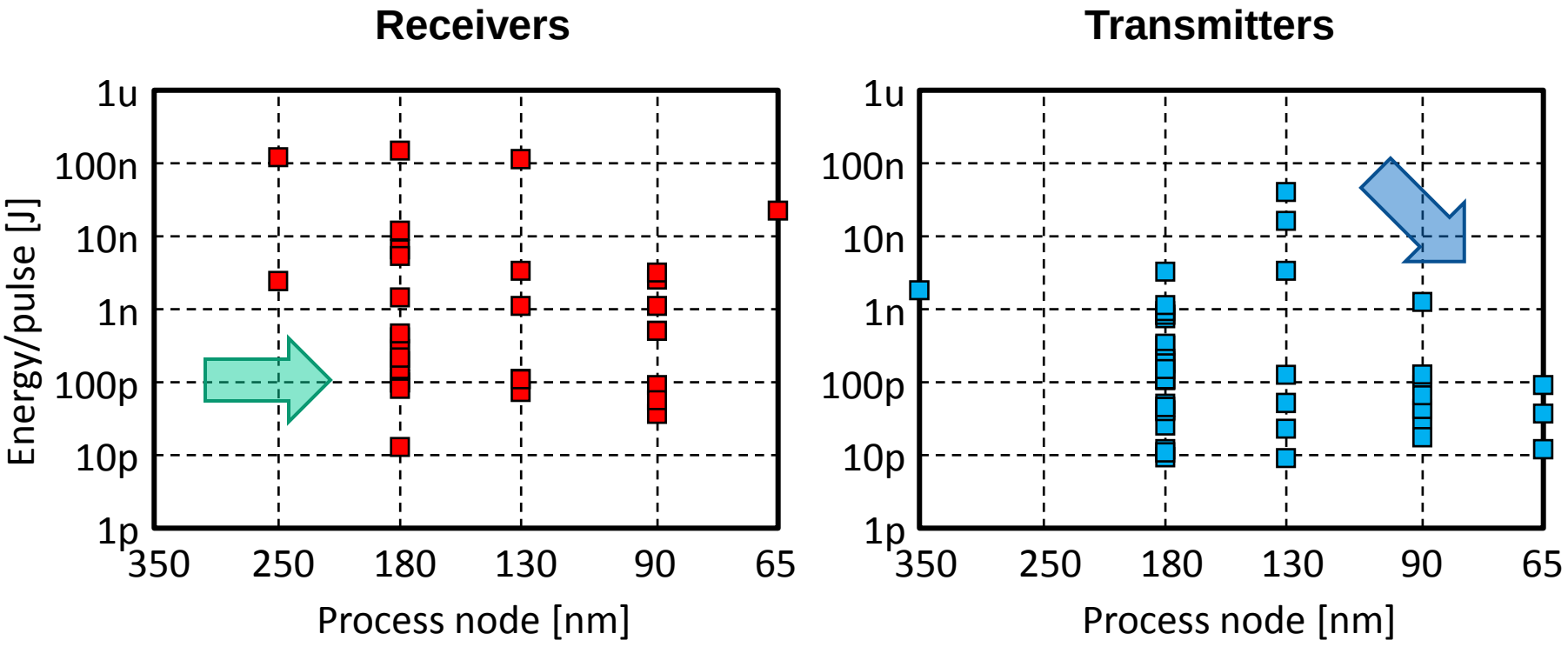
- **WiMedia Alliance – 2004**
  - OFDM-based solution, 480Mb/s, wireless USB
  - Never widely adopted
- **IEEE 802.15.4 – 2006 (WPAN)**
  - IR-UWB, 100kb/s to 27Mb/s, low-power modes
  - Support for positioning
- **IEEE 802.15 Task Group 6 – ongoing (BAN)**
  - Energy-constrained body sensor networks
  - Proposals include IR-UWB physical layer

Recent IR-UWB Publications



- **Rx energy 10x > Tx energy**
- **Rx shows trend, Tx no trend**

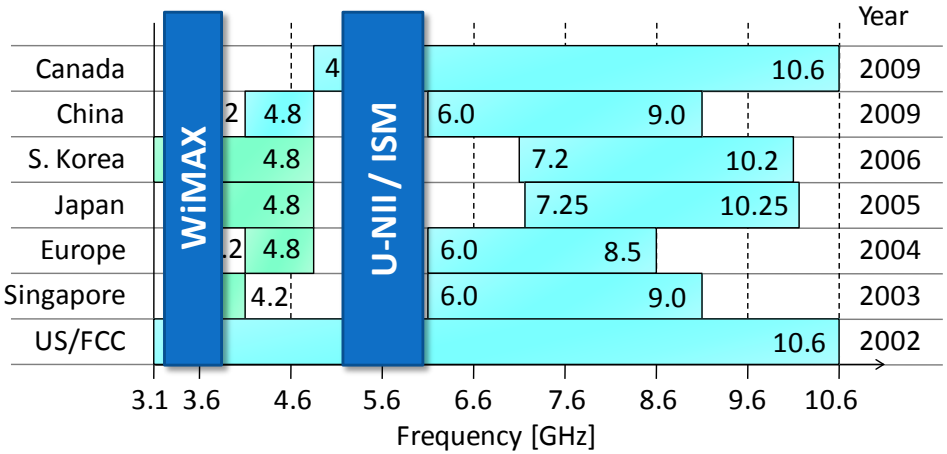
Recent IR-UWB Publications



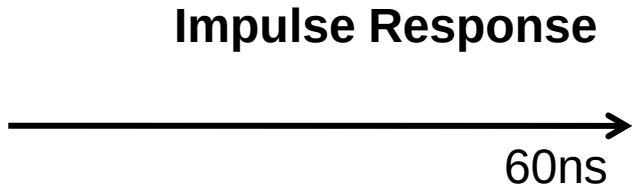
- **Rx shows no trend, Tx trend**
- **IR-UWB Tx favor mostly-digital architectures**

Challenges

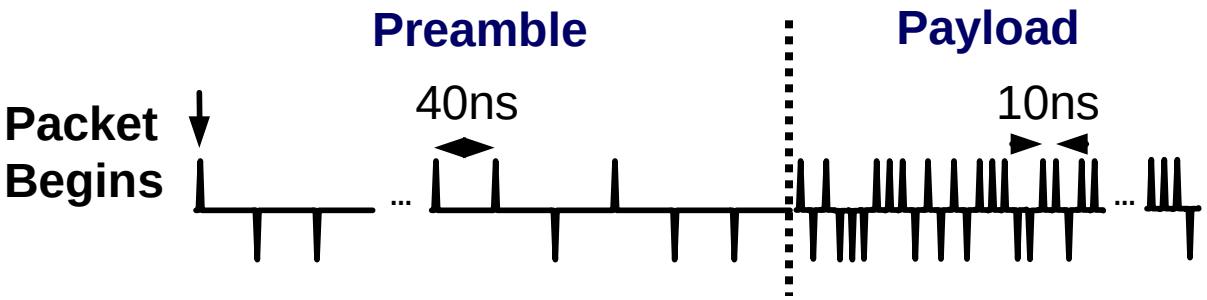
- **Interference from incumbent users**
  - Cancelation
  - Avoidance and filtering (most common)



- **Wireless response (multipath)**
  - Impacts datarates above 30Mb/s



- **Synchronization energy**
  - Impacts low-rate, energy-constrained systems



IEEE Transactions on Microwave Theory and Techniques
and
Antennas and Propagation
Announce a Joint Special Issue on
Ultra-Wideband (UWB) Technology

Areas of interest:

- Integrated circuits and systems
- Pulse generation and detection
- Low-power consumption techniques
- Positioning, tracking, and imaging
- Antennas and arrays
- Front-ends and antenna co-design
- Biomedical applications and wireless PAN/BAN
- Consumer electronics
- Ground penetrating radar
- 60GHz communication
- RFID

Guest Editors

Prof. David Wentzloff
University of Michigan

Dr. K.V.S. Rao
Intermec Technologies Corporation

Deadlines

Paper Submission: July 1, 2010

Publication Date: March 2011

Special Session: Recent Advances in IR-UWB Transceivers

- **Challenges and Recent Advances in IR-UWB System Design**
  Lutz Lampe, Klaus Witrisal
- **Partially Coherent Signal Combination for Impulse Radio Synchronization**
  Dries Neirynck, Kathleen Philips, Olivier Rousseaux
- **IR-UWB Transmitters Synthesized from Standard Digital Library Components**
  Youngmin Park, David Wentzloff
- **System and Circuit Considerations for Low-Complexity Constant-Envelope FM-UWB**
  John Gerrits, Mina Danesh, Yi Zhao, Yunzhi Dong, Gerrit van Veenendaal, John Long, John Farserotu