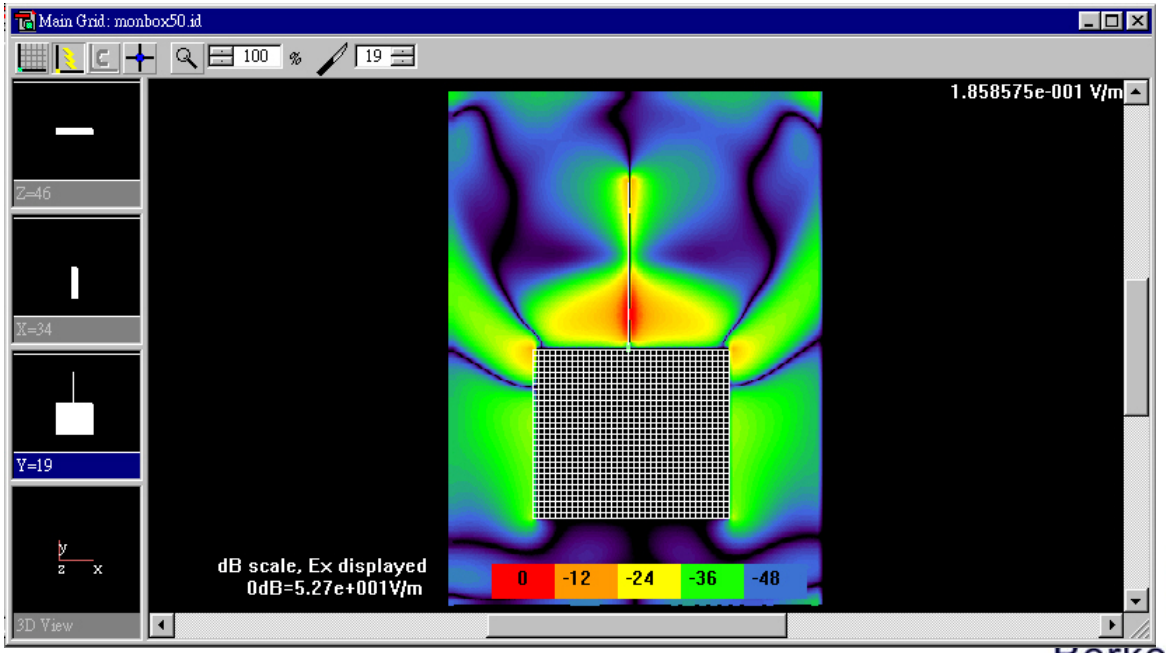
UWB Antennas

- Requirements of UWB antennas for our applications
  - Broadband
  - Small size
  - Omni-directional
- Antennas meeting the above specifications do exist, e.g. loop antennas are very good candidates. Large Current Radiator(LCR) is one of them.
- Use EM simulator to characterize the antennas
- How about the interface?
  - Deem the antenna as a filter and then co-design antenna and circuits

Simulation in EM simulator XFDTD

- Define the geometry & source → Run!
- Derive input voltage/current, input impedance, near/far zone transient fields, s-parameters, animation of the currents/fields/power flow, etc..



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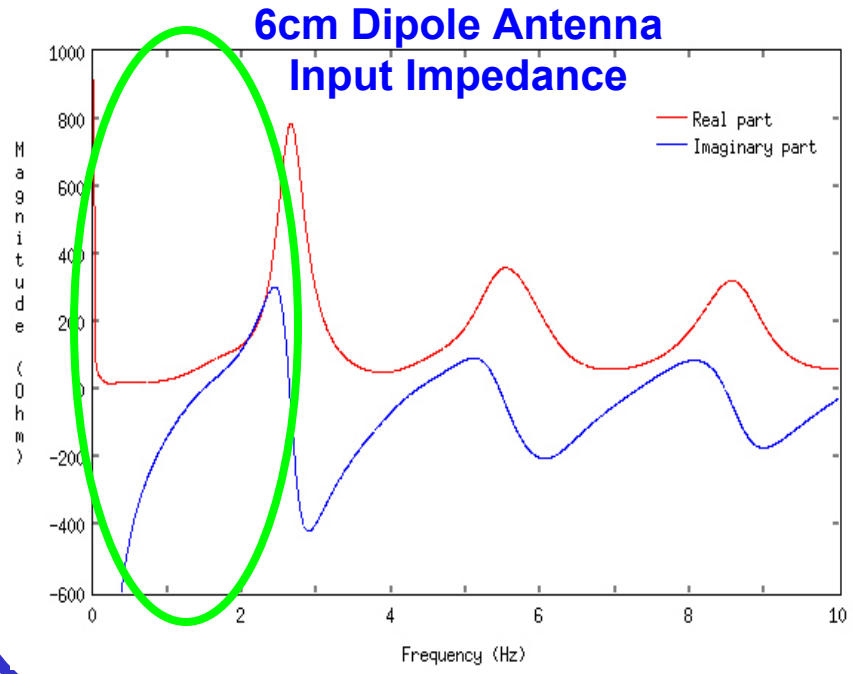
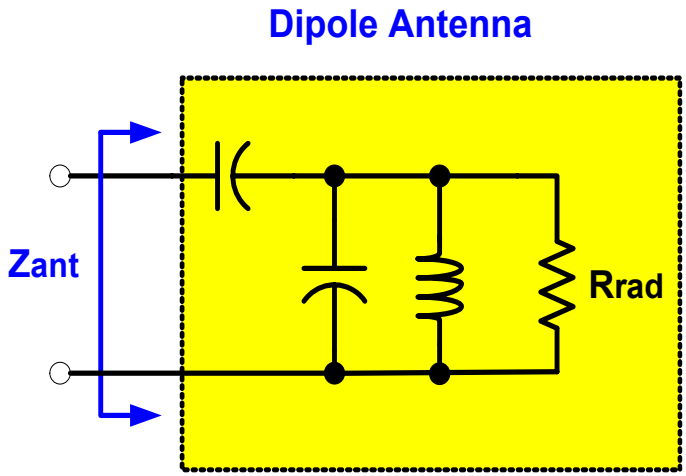
Modeling UWB Antennas

- Derive input impedance by simulations
- Voltage-drive antenna will be capacitor-dominant while current-drive antenna will be inductor-dominant





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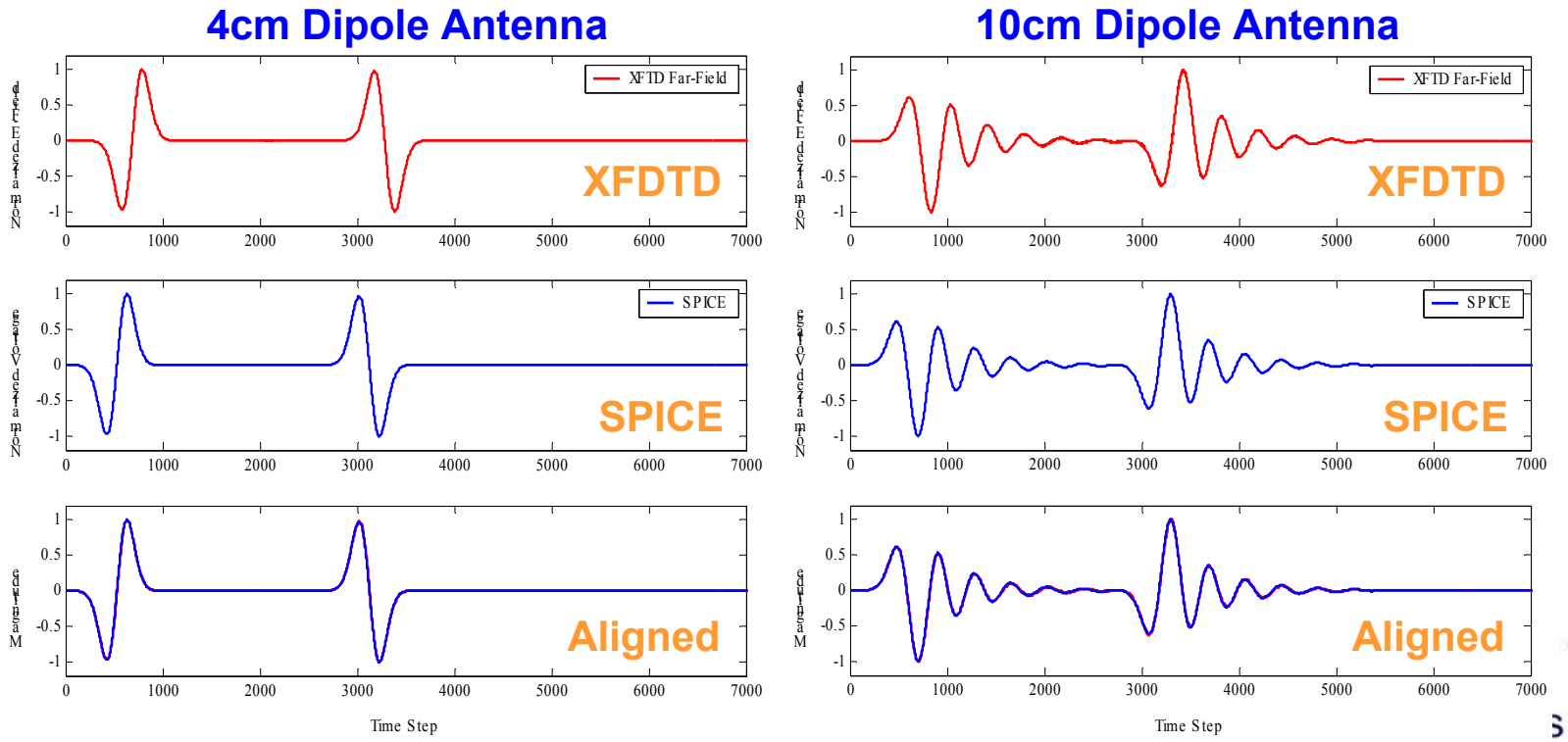
Dipole/Monopole Antenna Model

- Compare the far-zone E-fields and the voltage across the radiation resistors of 4cm and 10cm dipole antennas
- Stimulated by a pulse with 50ohm source resistance



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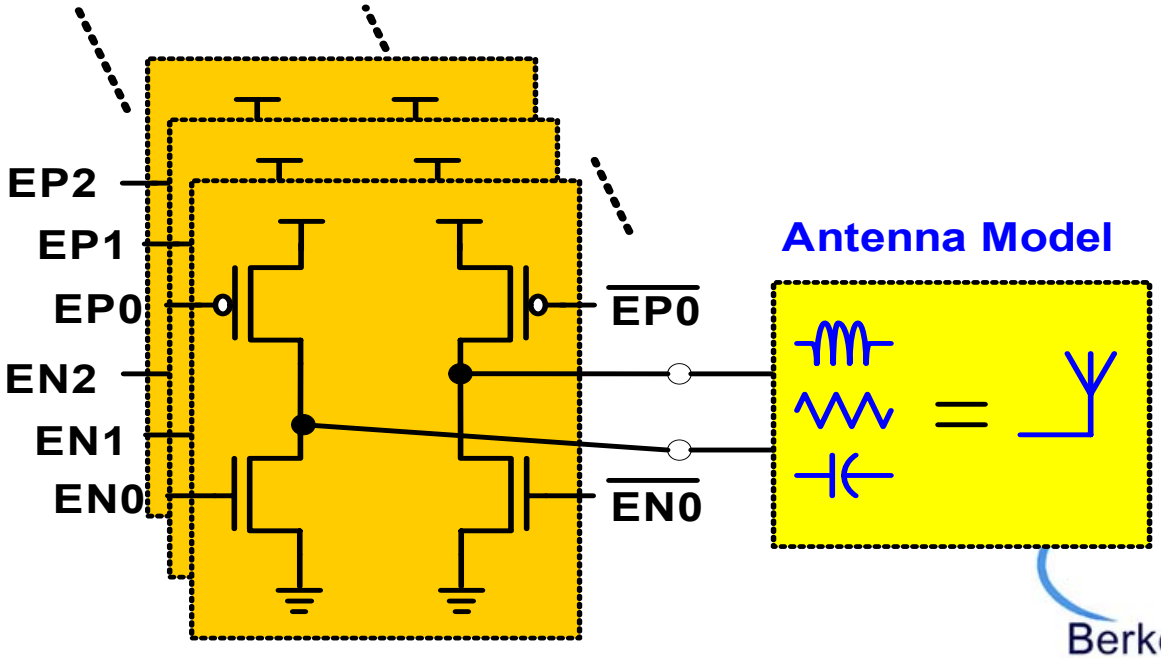
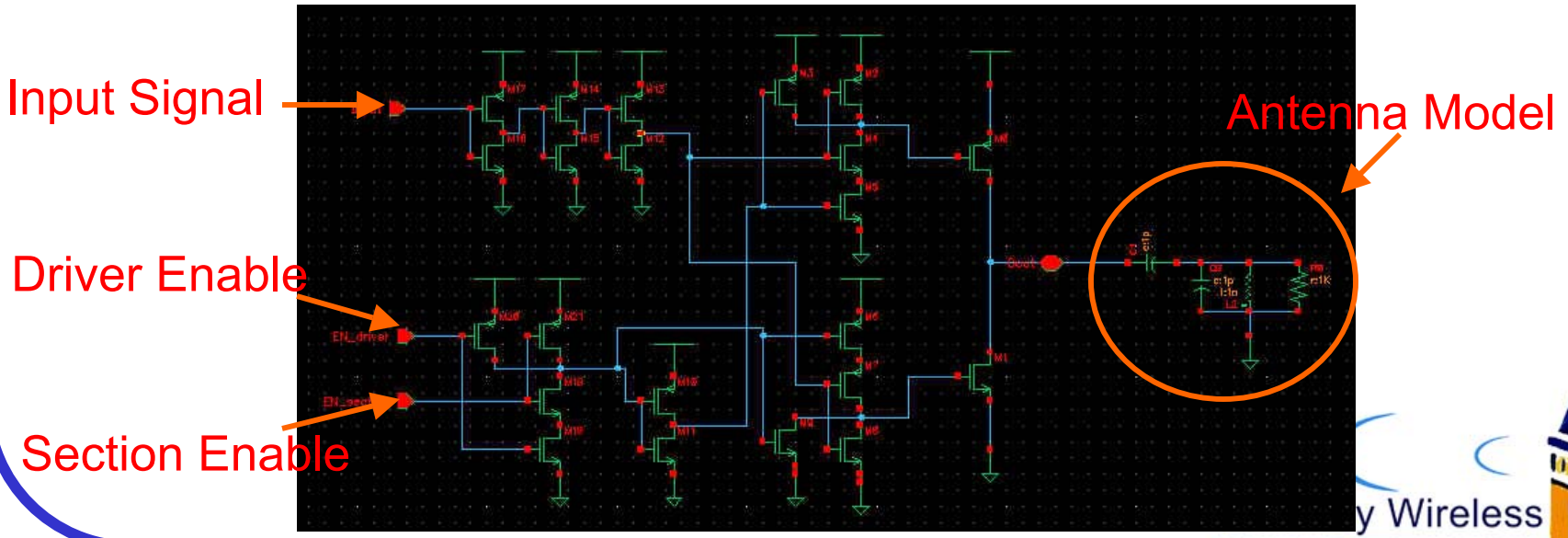
Flexible Antenna Driver

- Put the antenna circuit model into circuit simulator to design the driver
- H-bridge configuration
- Put them in parallel to make the driver flexible



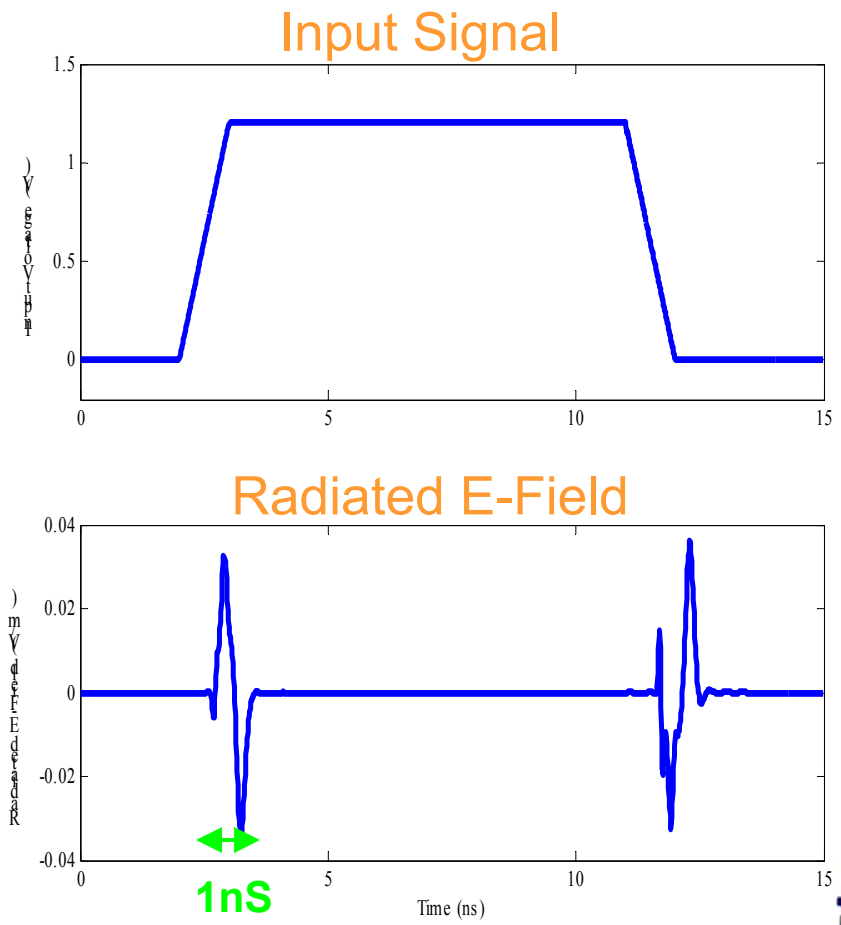
Driver Circuit Schematic

- Inverter chain sharpens the edge of the input signal
- Pre-driver NAND/NOR circuits skew the signals
  - Enable/Disable the driver
  - Avoid short-circuit current
  - Make the pulse radiated more balanced



Driver Circuit Simulation

- 1ns rise/fall-time input pulse
- Gaussian-derivative-shape waveform of the radiated E-field
- Imperfection of the waveforms due to nonlinearity of the driver and coupling between internal nodes



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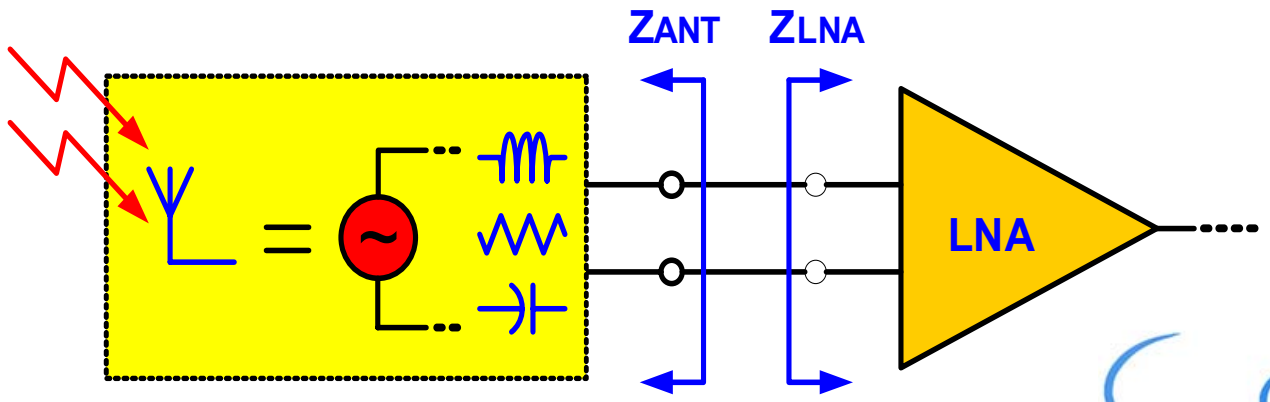
Antenna/LNA Co-design

- Impedance of the Rx antenna seen by LNA is the same as that of the Tx antenna
- Optimize LNA by putting the antenna model in front
- Usually voltage-drive RX antennas prefer large Z_{LNA} and current-drive antennas prefer small Z_{LNA}



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Example: Monopole Rx Antennas

- 2cm monopole antenna with different loading
- Larger Z_{LNA} gives higher LNA input voltage
- Mismatch due to scattering and near-zone field
- The relative magnitudes are close