Wednesday February 18, 2015

BLUETOOTH SMART© SOLUTIONS FOR TINY METAL OBJECTS
TECHNICAL TRADE OFF AND SOLUTIONS

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Insight SiP France

AGENDA

- Insight SiP
- Introduction
- Metal Case Connected Watch
  - Metal Case Description
  - Design process
  - Design Example
  - Performance
  - Link Budget
- In-ear Hearing Aid
  - Design Example
  - Performance
  - Link Budget
- Conclusions

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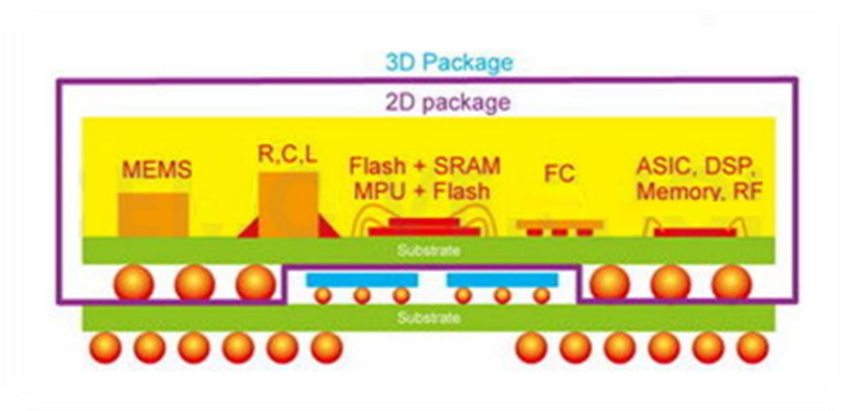
Insight SiP

- Established in 2005
  - Core team from National Semiconductor
- Experts in RF System-in-Package (SiP)
  - Design & industrialization expertise
  - Fab-less company

- Product Lines
  - Providing turn-key design services and creative packaging solutions
  - Providing standard modules for wireless electronic industry
- Locations
  - Europe – Technical team at Sophia-Antipolis - France
  - North America – Subsidiary in Denver since 2008
  - Asia – Sales office in Tokyo since 2008

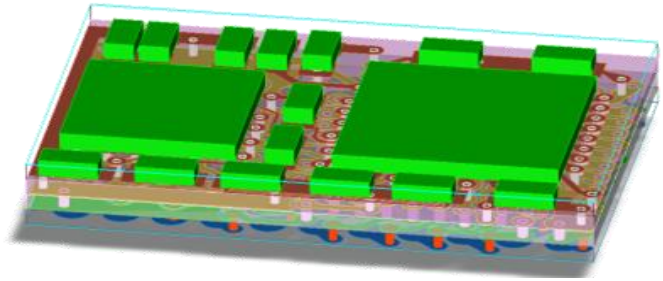
SiP Expertise



- Core Competencies
  - Any Wireless connectivity to fit any device space
  - System-in-Package (SIP) design approach
  - Highly integrated antenna design expertise
  - Unique methods to estimate package size and performance
  - Optimization Size/Cost/Time to Market
  - Multiple Technologies : BT, FR4, LTCC, HTCC, Thick Film, PCB, IPD,…
  - Multiple Assembly Methods: SMT, Wirebond, Flipchip, Embedded Dies…
- Technical Successes
  - 3G, ANT, BLE, Bluetooth®, GSM/W-CDMA, GPS, ISM, LTE, NFC, RFID, UMTS, UWB, WHDI™, WiFi, WLan, Zigbee ® …

Benefits to our customers

Smaller, Faster, Lower Cost



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Introduction

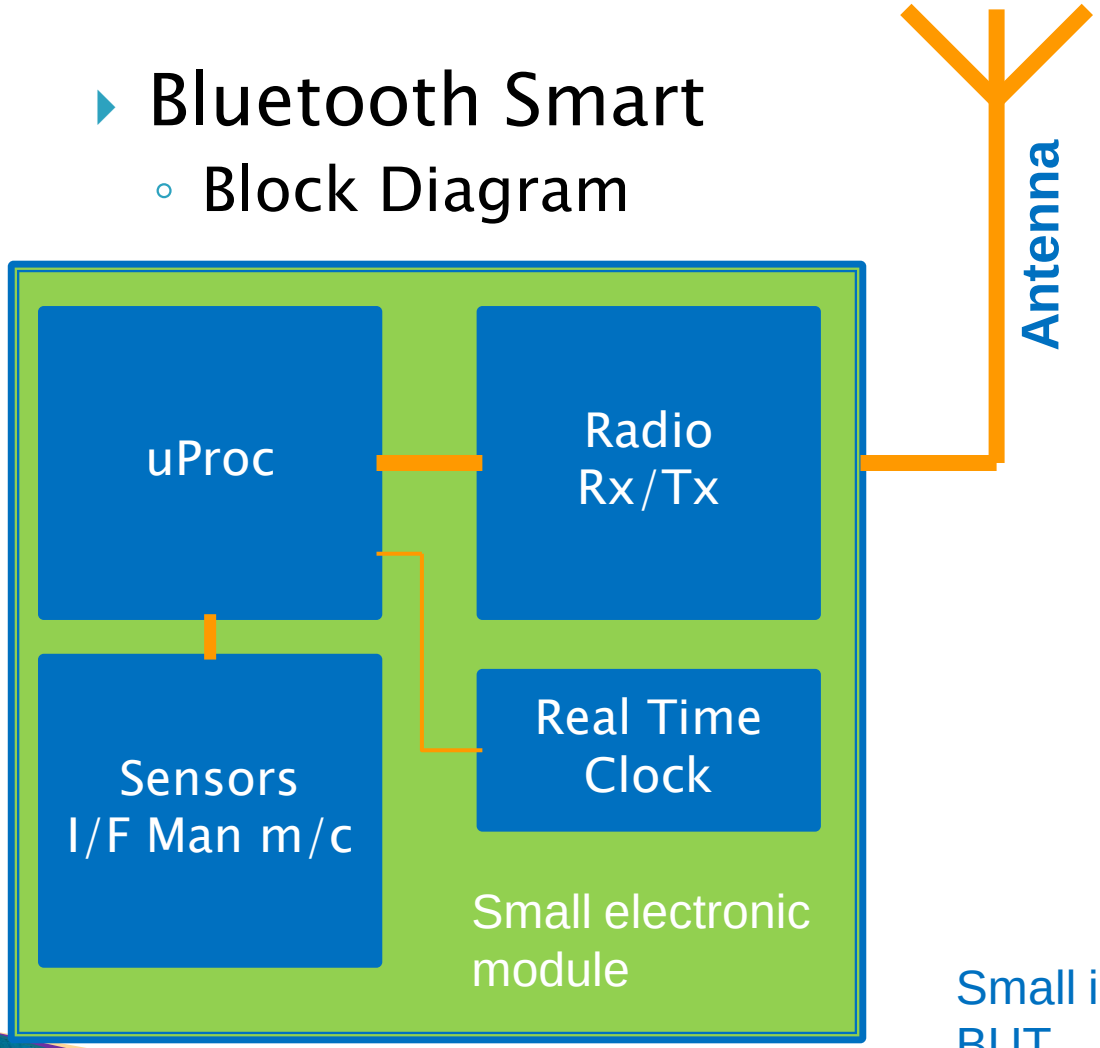
- Bluetooth Smart
  - Dominant Standard for short range communication
    - Reduced power consumption of individual functions <10mA radio

Mostly Off

Smart Bluetooth

Introduction 2

- Bluetooth Smart
  - Block Diagram

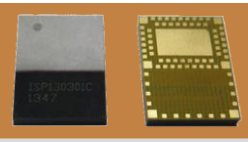
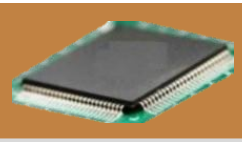


Smart Bluetooth

Small is beautiful
BUT
Will it Work?

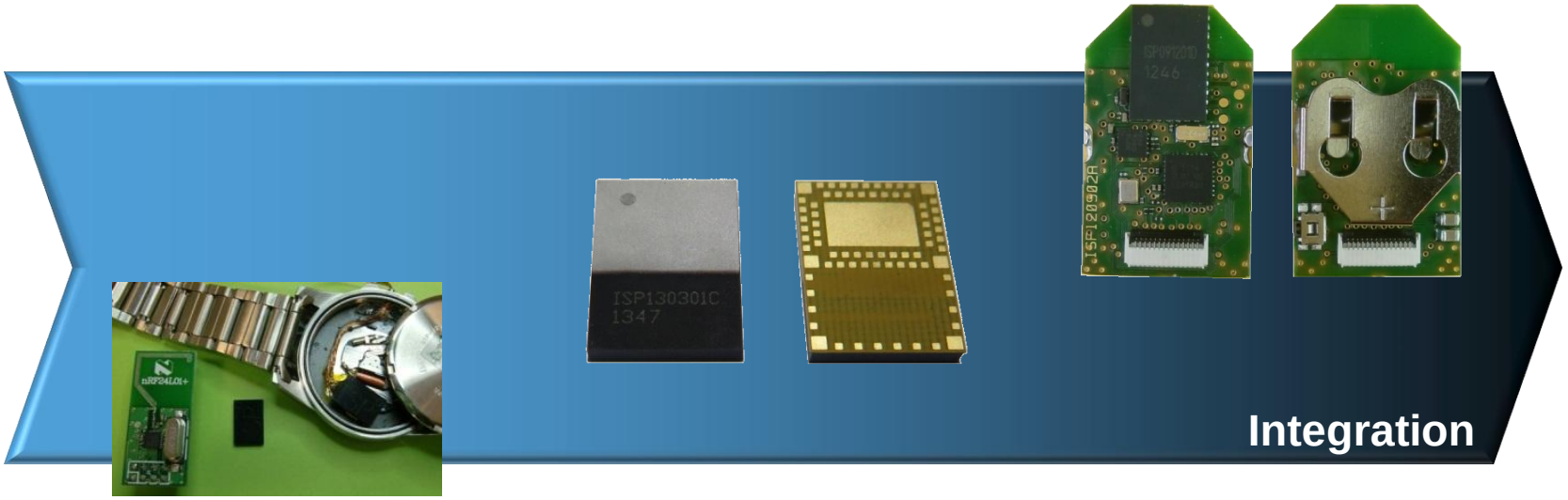
Module or Discrete ?

- Need to check overall project cost and duration between both solution

	Module 	Chip + Discrete 
RF design	Core competency of module vendor Heavy 1-time investment	Expertise required for layout, signal routing, layer stack-up, interference, shielding
Size	Optimized size	Non module may require larger area on target PCB
Procurement	1 component	Multiple components
Complexity	Like any component to place	RF design and RF yield
Assembly	1 component ready to mount	Complex Bill Of Material (BOM)
Test	Module fully tested (behaviour, Electromagnetic, placement,…)	Need full test on end-product
Yield	100% yield ready modules	Yield losses in production Failure analysis & rework costs
Quality	Modules are fully tested and provided as known good	RF expertise and test flows to cover connectivity systems
Certification	Pre-certified / already certified	Certification from scratch

Module or Discrete ?

- Insight SiP intends to propose a complete BLE solution offer to our customers



Discrete solution
✓Radio and application both designed on customized circuit

Module solution
✓Radio included in a module integrated on application circuit
✓Custom or Off shelf

Sensor solution
✓Ready to Use Radio and Hardware circuit
✓Custom or Off shelf

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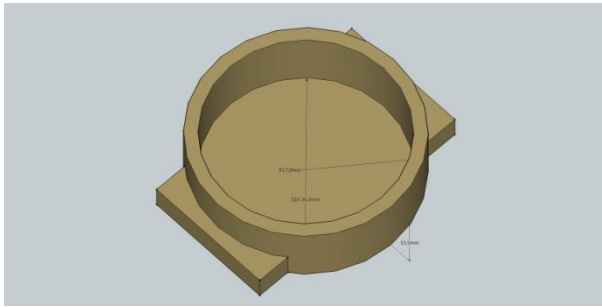
Metal Case Connected Watch

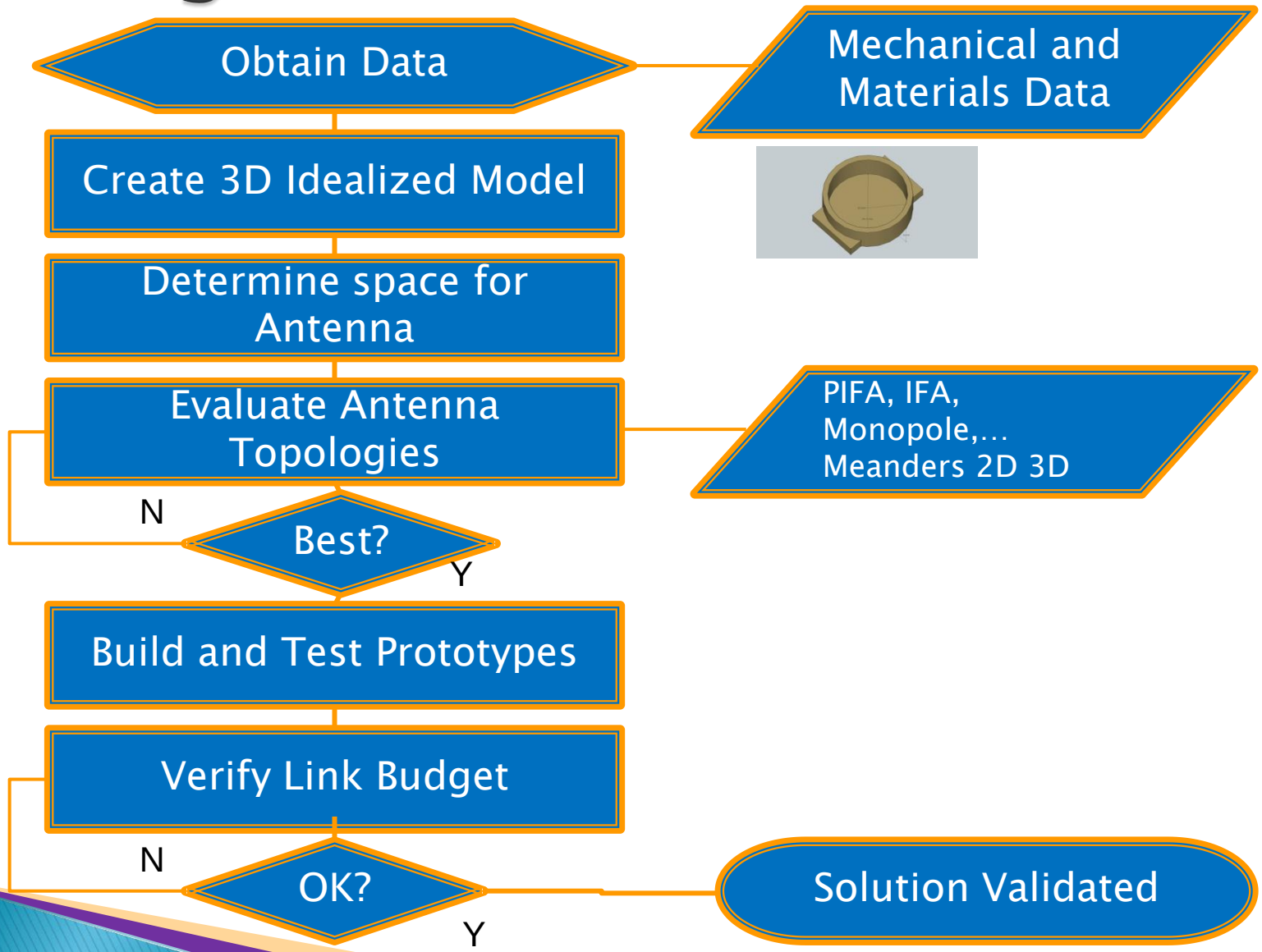
- Stylized Metal Watch Case
  - 28 to 35 mm diameter
  - Height 10 mm
    - Reduced power consumption of individual functions <10 mA radio
    - Electronics under movement
    - Antenna close to Electronics
    - Antenna near back plate



Mostly Plastic

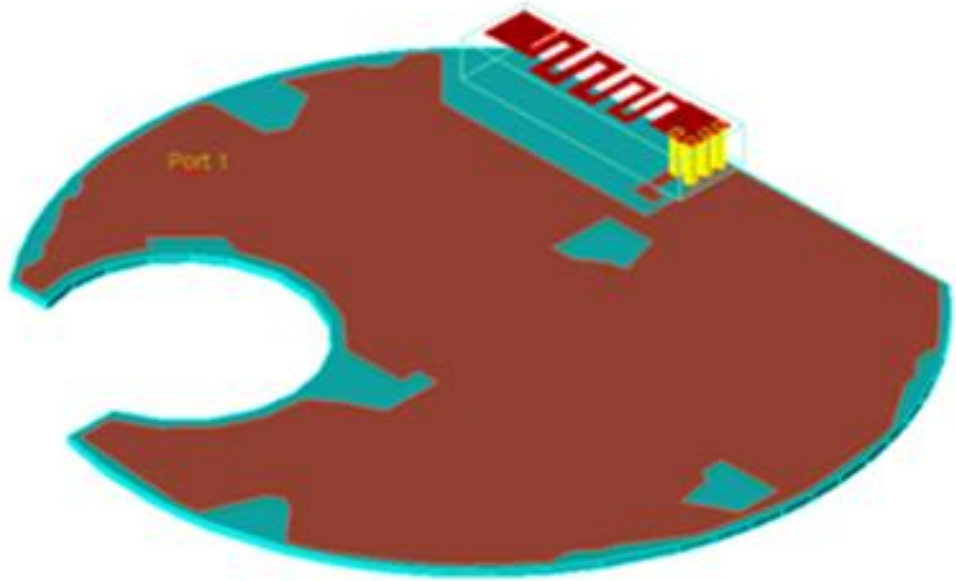
All Metal

Design Process



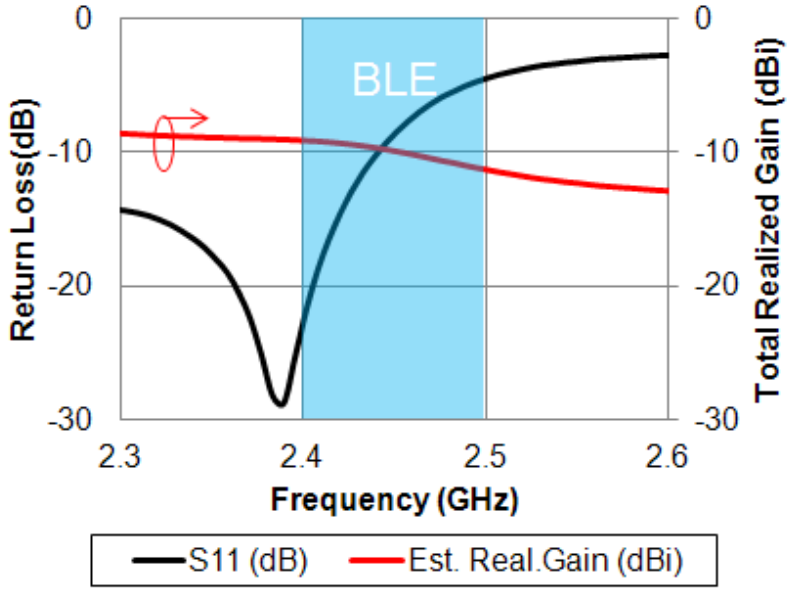
Design Example

- Constraints
  - Near watch back (2mm)
  - Small size (<30mm²)
  - Near watch side walls
- Best Structure
  - PIFA 3D type



Optimum Performance

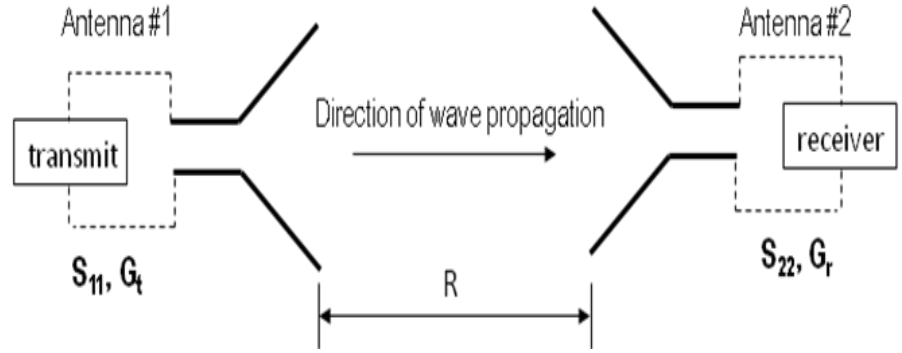
- Measured Prototype
  - Needs small re-centering
  - Gain ca −9 dBi
  - Return loss > 6 dB



Link Budget

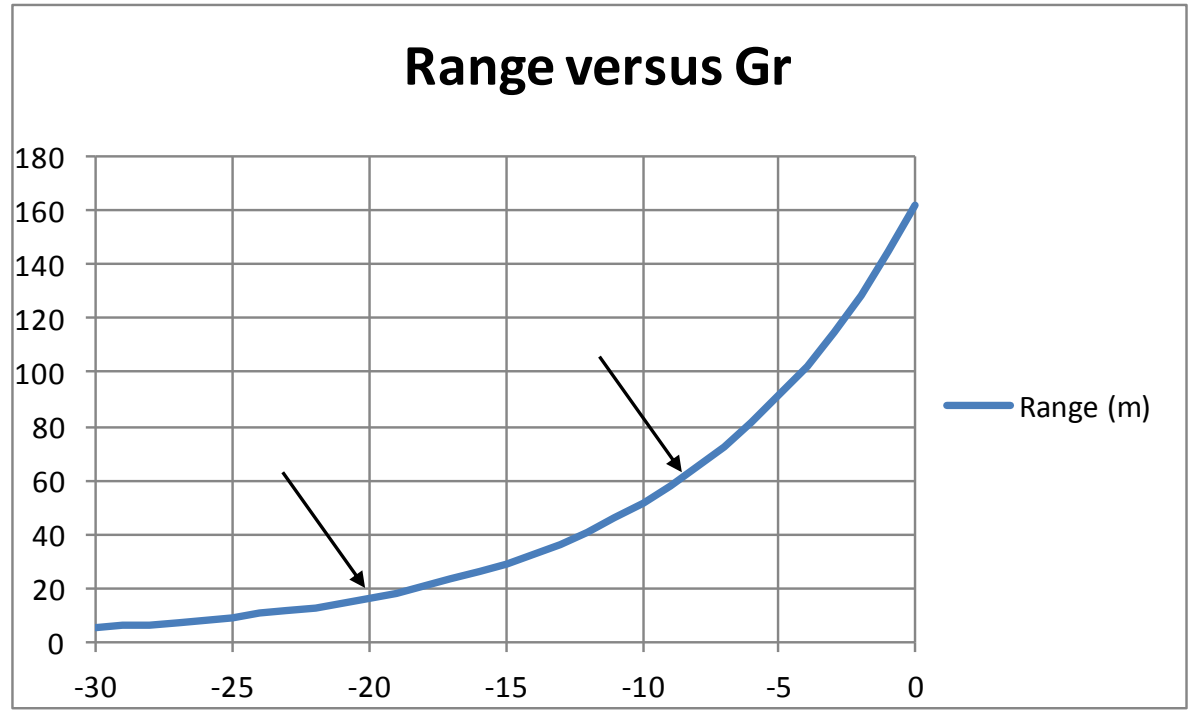
$$\frac{Pr}{Pt} = GrGt(1-S11^2)(1-S22^2)\left(\frac{\lambda}{4\pi R}\right)^2$$

- Parameters
  - Pt – Transmit Power *0dBm*
  - Pr – Received signal at sensitivity level *–85dBm*
  - Gt – Transmit Antenna Gain *0dBi*
  - Gr – Receive Antenna Gain *–9dBi (from measurements)*
  - S11 and S22 – *6dB Return Loss*
  - λ Wavelength – *122cm*
  - R – Range



Link Budget as Function of Gr

- Link Budget
  - Bluetooth Smart
  - Cell Phone Gt 0dBi
  - Tx power 0dBm
  - Rx sensitivity −85 dBm
  - Slave antenna Gain Gr
  - Gr=−9dBi
  - ➔Range 60m
  - Gr=−20 dBi
  - ➔ Range =18m



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In-Ear Hearing Aid

- In-Ear Hearing Aid
  - Tiny Form Factor
    - Battery
    - Microphone
    - Loud Speaker
    - Electronics
  - Bluetooth Smart
    - Add Antenna
    - It is inside the head
    - Must be very small

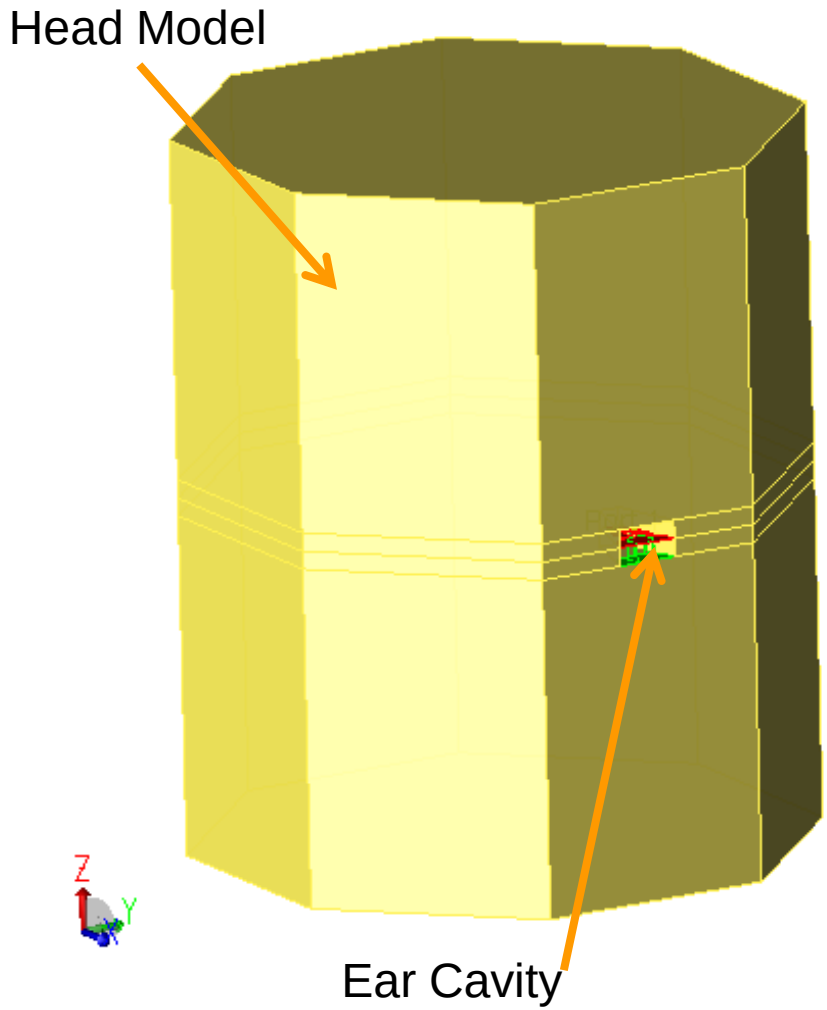
Design Example

- Major Challenges
  - Antenna space is tiny
  - Antenna is surrounded by absorbing soft tissue

Freq (MHz)	ε'_r	ε''_r	σ (S/m)	ε_r	tg δ
2450	52.7	14.3	1.9	54	0.27

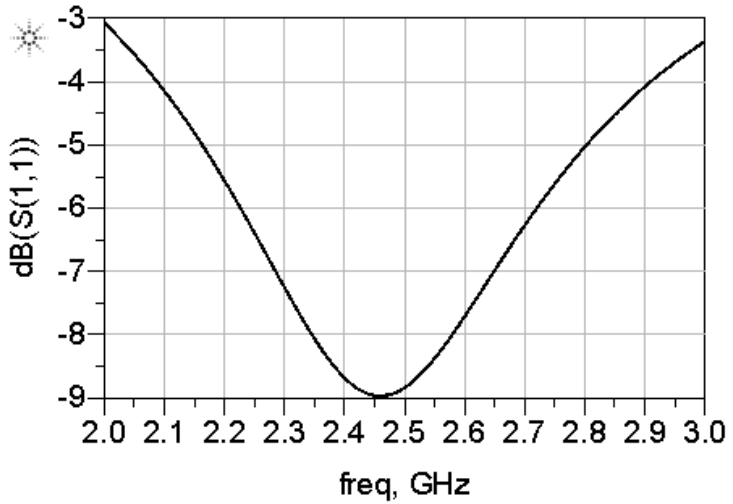
Simplified Human Head Model

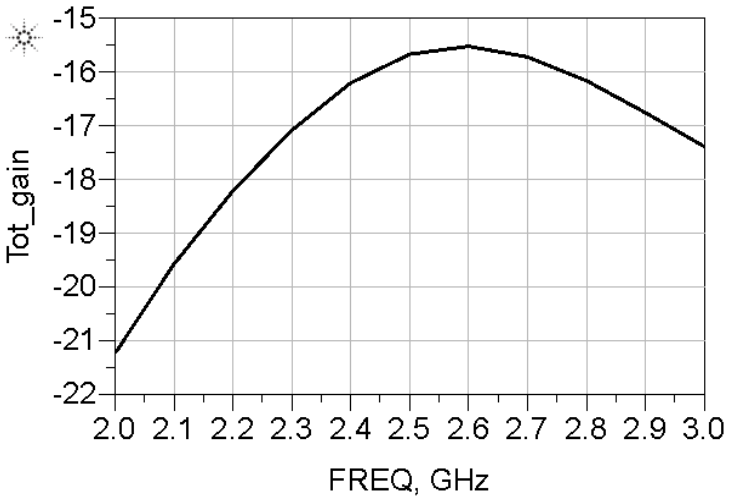
- Head Model
  - Octagonal Prism
  - Filled with dielectric
  - Small Air Cavity = Ear



Optimum Performance

- Return Loss > 6dB in band
- Total Gain > -16 dBi in band

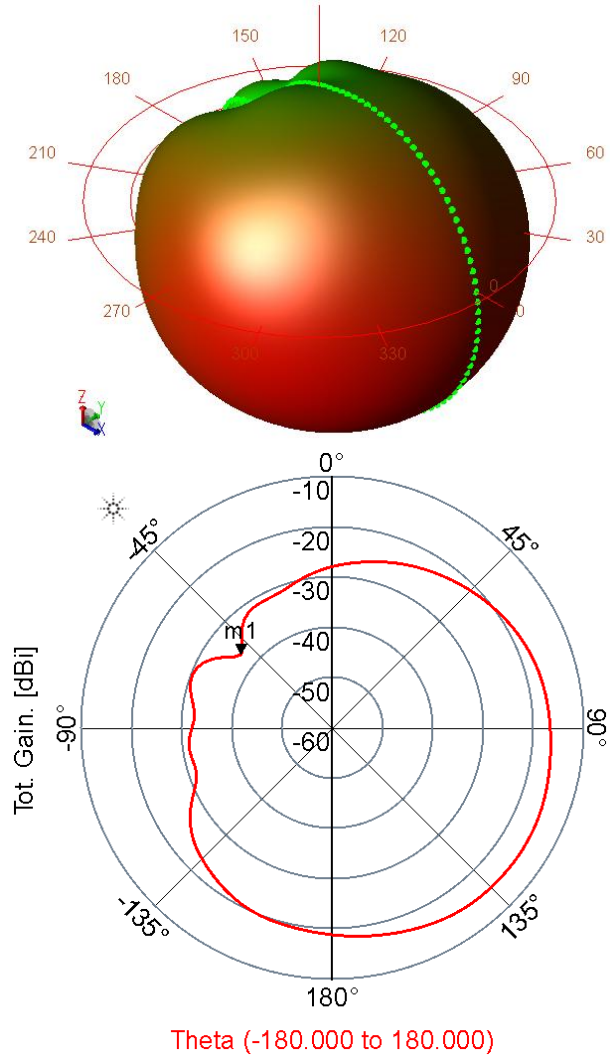




Radiation Patterns

- Gain -16dBi towards outside
- Gain -35 dBi in worst case position “through the head”

Max. gain (dBi)	Max. free space range R_{max} (m)	Multipath error correction $\alpha = 0.6\ R_{max}$ (m)
-16	25	15



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- Design of Small Smart Bluetooth Antennas proven
- Take into account all material and size constraints
- Accept Link Budget compromise/tradeoff
- Connected metal watch range >> 10m
- Hearing Aid range > 1.5m worst case