



# Beyond GPS

September 2007





# Executive Summary

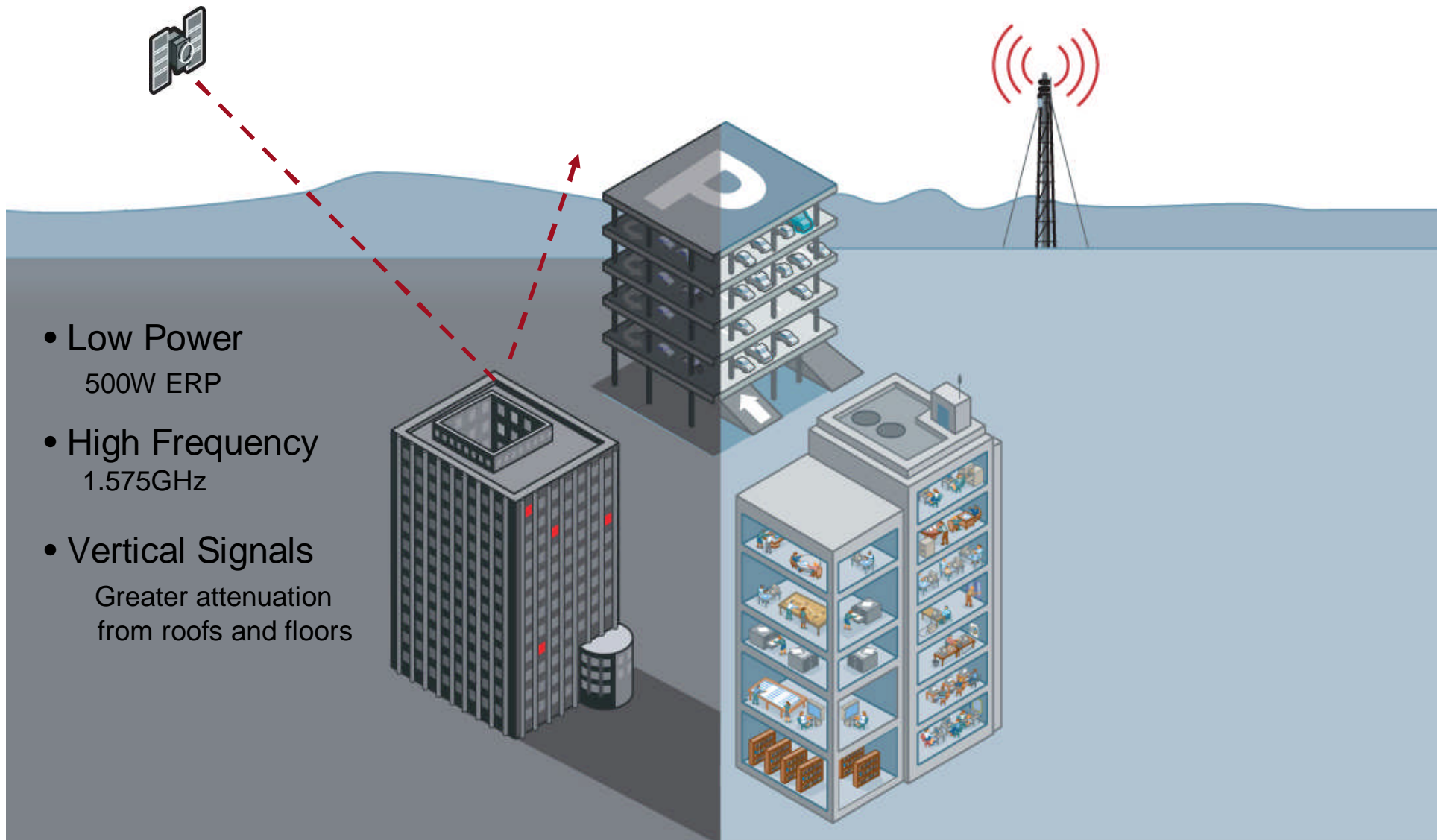
- The Need: A better, faster, cheaper way for connected and mobile devices to determine their location, with high accuracy, on a nearly continuous basis, indoors and out, based on robust infrastructure. GPS doesn't suffice.
- The Solution: Use mobile and terrestrial TV signals and Rosum's patented signal processing algorithms to achieve rapid, accurate, and continuous location fixes indoors and out. Always-On Location for a new generation of social, advertising and commerce-driven applications.
- The Market: Location capability adds value to anything that's portable. The entire mobile electronics value chain (phones, PC's and gadgets) wants location capability in order to unlock LBS and LBA revenue streams.
- The Company: Depth in Location and Consumer Electronics
  - Chairman Jim Spilker, original GPS architect
  - CEO Skip Speaks, CEO Kyocera Wireless USA
  - CTO Matt Rabinowitz, Navigation Expert, MIT TR35
  - VP Engineering Dimitri Rubin, Wheels of Zeus
  - Board/Advisory: Brad Parkinson, Chief GPS architect; Per Enge, Stanford GPS Lab; Jim Gibbons, Stanford Engineering Dean, Cisco Board Member; Paul Baran, Invented Packet Switching, Founded Metricom, Telebit, Stratacom





# The Problem with GPS

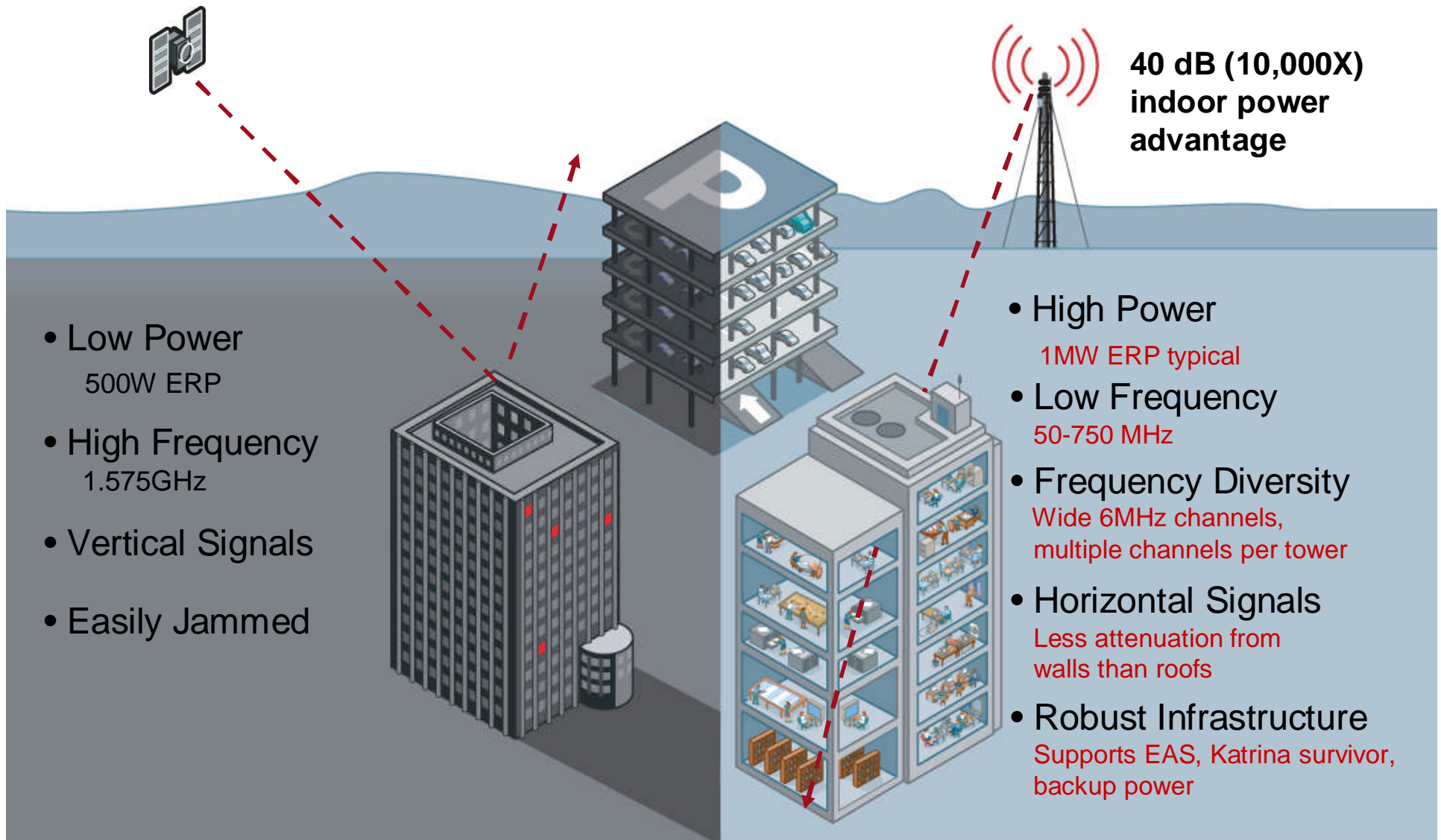
*Building attenuation and reflection make GPS unreliable in urban and indoor areas*





# TV-Positioning is Robust Indoors

*TV possesses multiple advantages vis-à-vis GPS for indoor & urban area positioning*

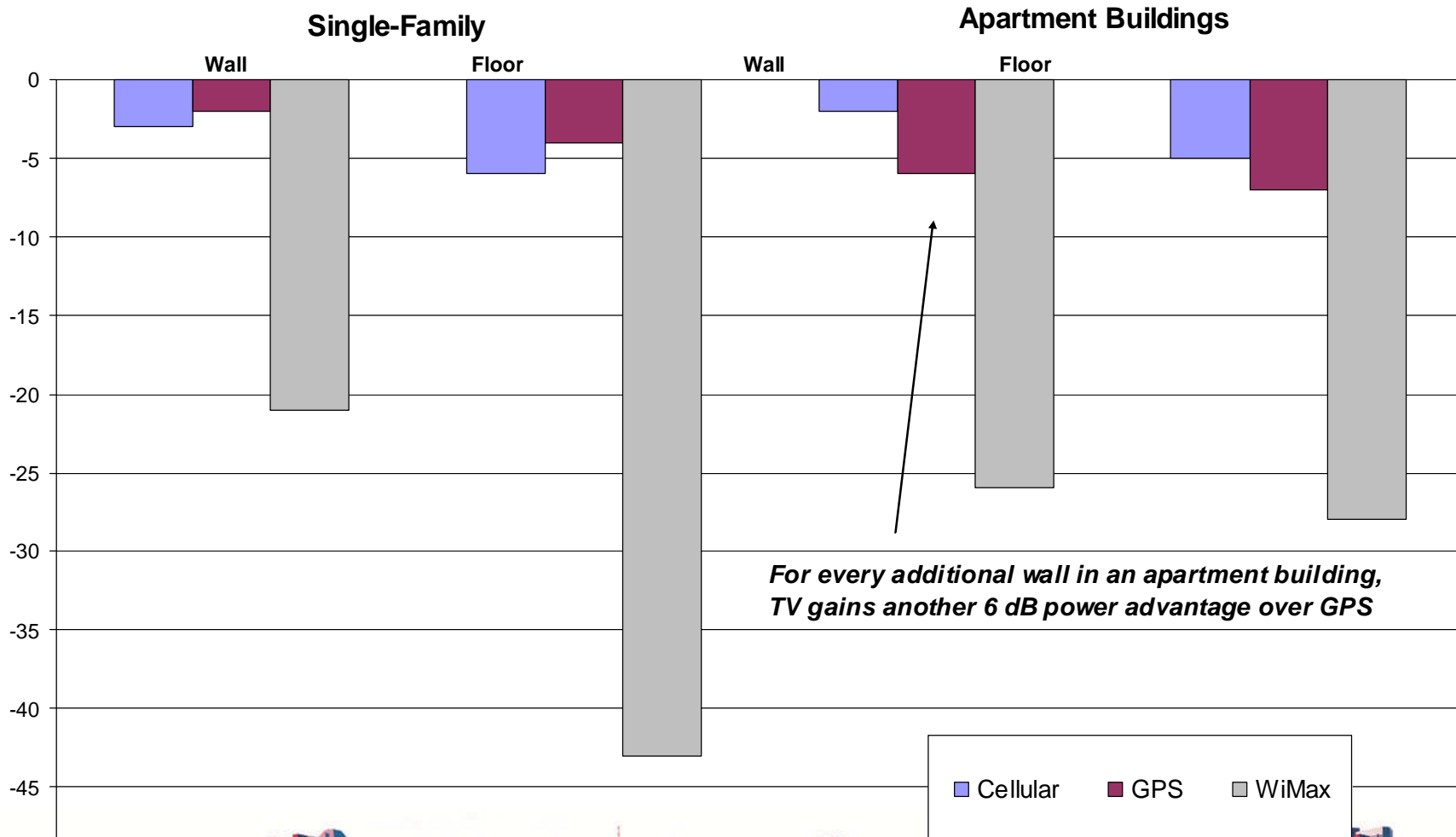






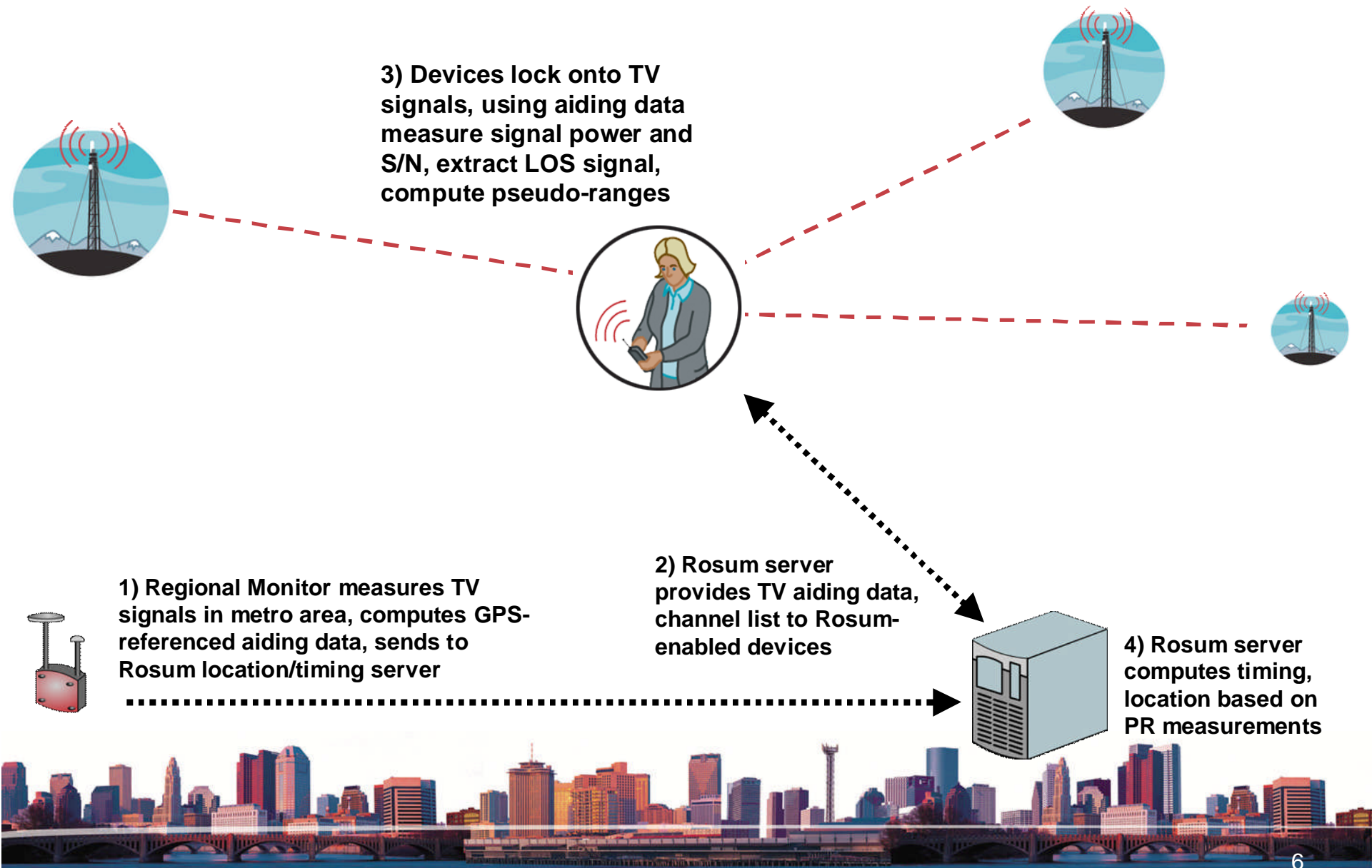
# TV's Advantage is Greater with Every Wall/Floor

## Marginal Power (dB) Relative to TV in Indoor Settings



Source: NIST Construction Automation Program Report No. 3 *Electromagnetic Signal Attenuation in Construction Materials*  
National Institute of Standards and Technology, October 1997.

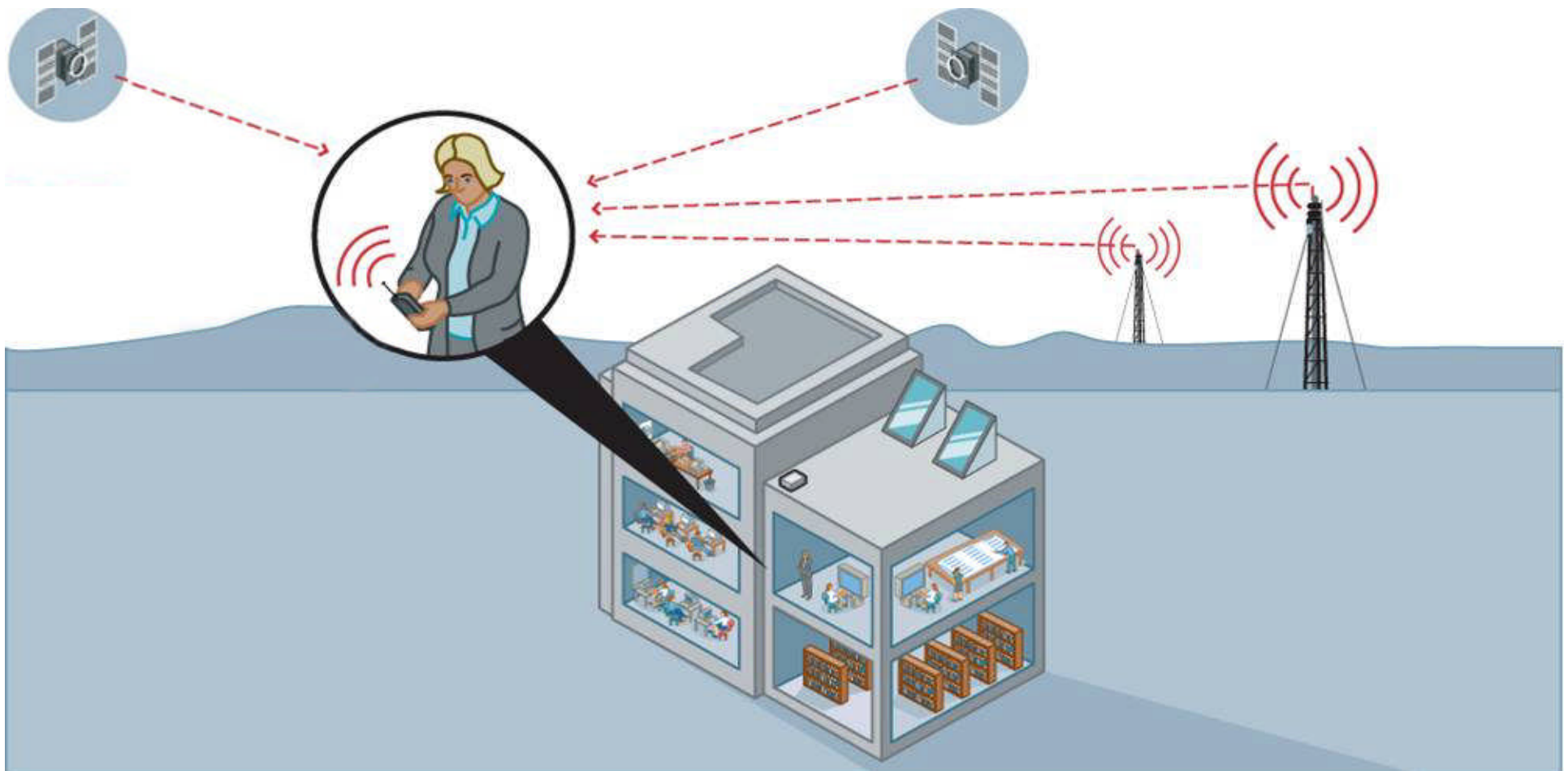
# How TV-Positioning Works





# TV+GPS Hybrid Positioning

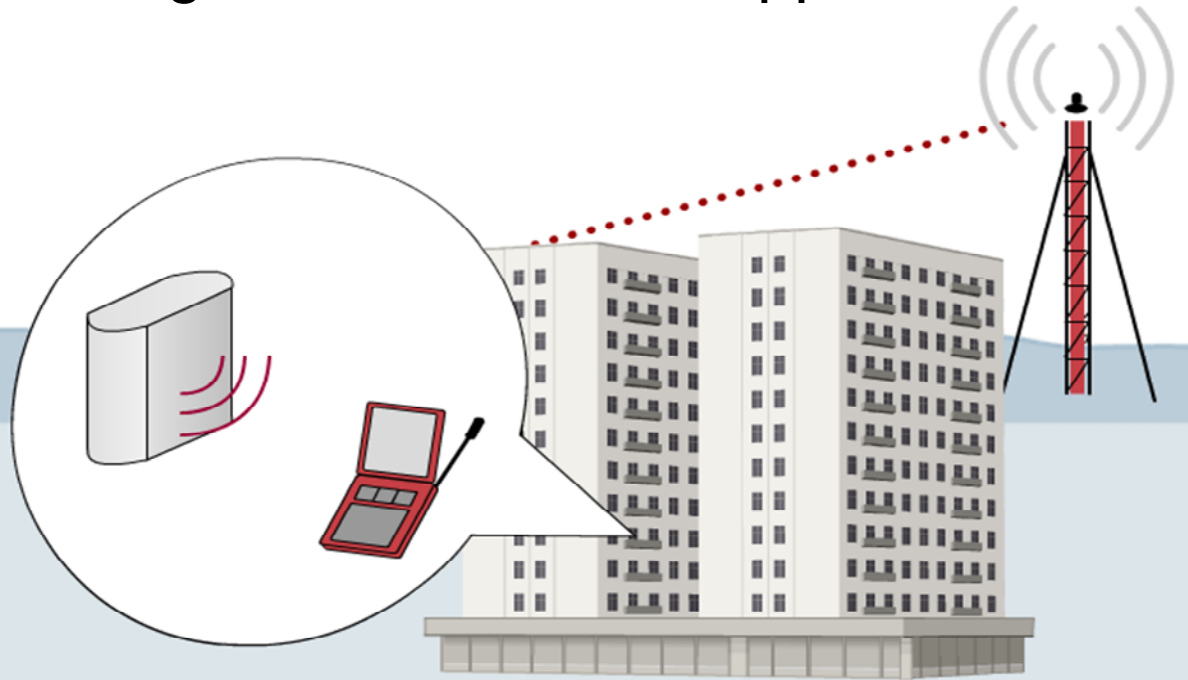
Hybrid positioning provides our customers with the indoor + urban availability of TV and the broad coverage of GPS





# In-Building Timing Solutions

Rosum can provide cost-effective frequency stability and absolute timing for in-building communications applications.



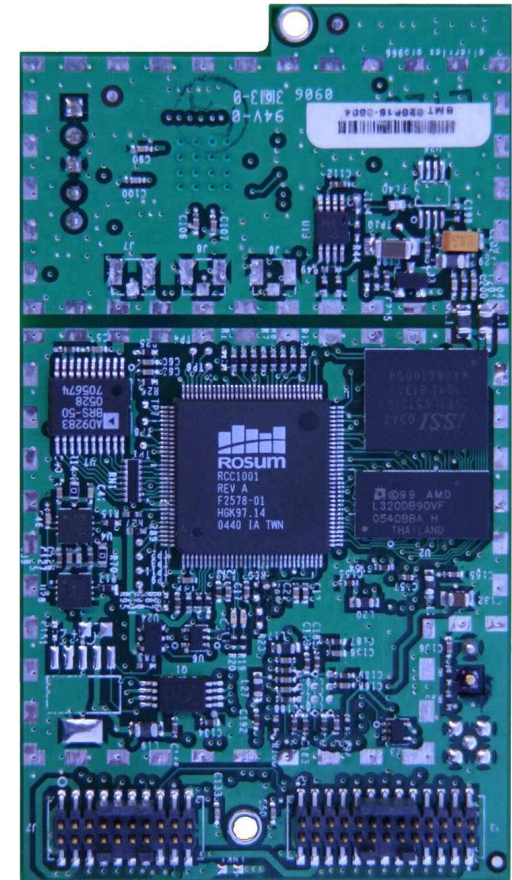
- Frequency stability can be provided to 10ppb
- Absolute timing can be provided to  $1\mu\text{s}$





# Hybrid Positioning Module – Available

- HPM includes:
  - TV-positioning (analog and digital)
  - Global Locate Hammerhead AGPS
  - Integrates ranging information
- HPM is trial/evaluation platform:
  - VoIP Trials
  - E9-1-1 Certification Testing
  - Hybrid Positioning



***Rosum HPM***



# The Proof is in the Pudding

August 2007

Site	Location	Construction	TV-Positioning	Hi-Sensitivity A-GPS
Pizza Hut	2695 El Camino Real	Easy	39m	66m
Mexicali Grill	3149 Mission College Blvd.	Easy	26m	54m
Hilton	4949 Great Am. Pkwy SC	Moderate	32m	2396m
Diesel Store	378 Santana Row SC	Moderate	75m	Failed
SCCC Parking Deck	5001 Great Am. Pkwy SC	Difficult	52m	Failed
City Hall Coffee Shop	1500 Warburton Ave. SC	Difficult	46m	Failed
Montgomery BART Stn.	Market & Sutter Underground	Extreme	54m	Failed

Excellent	Good	Bad	Failed
-----------	------	-----	--------

A-GPS device allowed to acquire satellites outdoor before being taken indoors. Within one minute satellite visibility did not support positioning.





## E9-1-1 Compliance Testing Results

### Test conducted:

- 3<sup>rd</sup> party testing based on FCC OET-71
- **50% indoor, 50% outdoor testing** to mirror actual consumer 9-1-1 calling patterns
- ATIS 0500011 guidelines followed for indoor tests
- Goal is to show that Rosum supports FemtoCell, VoIP, Indoor Wireless
- 5 PSAPs tested
- 30 sites/PSAP

PSAP	67% CEP	95% CEP	Handset-Compliant
Washington, DC	49m	85m	Yes
Edison, NJ	50m	83m	Yes
Santa Clara, CA	36m	65m	Yes
Needham, MA	33m	63m	Yes
Nashua, NH	31m	66m	Yes



# Femtocell Solutions – Rosum Works

Technology	CDMA		UMTS	
	Location	Timing	Location	Timing
Rosum	✓	✓	✓	✓
GPS		✓		✓
Network Timing				✓
Self-Registration	✓		✓	

**complete solution: ✓**    **partial solution: ✓**

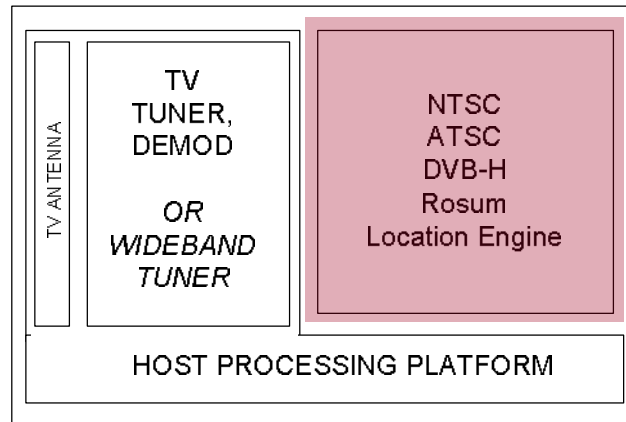




# Low-Cost Receiver Implementations

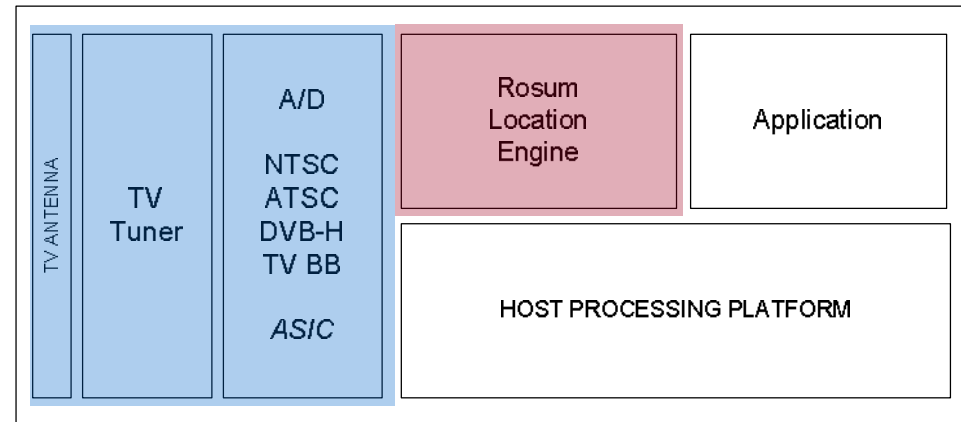
SOFTWARE

HARDWARE



HOSTED

Mobile TV  
Trials 4Q07



STAND-ALONE

Femtocells, VoIP  
3Q08







# Mobile TV Applications

---

- Rosum has executed an agreement with a mobile computing platform provider (to be announced)
- Rosum has demonstrated TV-positioning in S. Korea and has signed a market agreement with Trimble.
- Rosum will enable applications including:
  - LBA
  - PND
  - White Space Awareness
  - Asset Recovery
  - Security





# Rosum Recognition and Awards



May 2005 – Rosum named a **Red Herring 100 Technology Company** for 100 top start-up technology companies.



October 2005 – **MIT Technology Review** named Rosum co-founder & CTO Matthew Rabinowitz to the **TR35**, the list of the top 35 technology minds under age 35.



December 2005 – **World Economic Forum** selected Rosum for its **Technology Pioneer Award** as an innovative, transformational technology with long-term market and societal impact



January 2006 – Rosum named **Frost & Sullivan 2006 Market Enabling Technology of the Year** for its VoIP E9-1-1 call location technology



September 2006 – Rosum founders Dr Jim Spilker and Dr Matthew Rabinowitz received **IEEE BTS Transactions Best Paper Award** for white paper on DTV positioning



February 2007 – Rosum Chairman Jim Spilker, Technical Advisor Brad Parkinson, and Board Member Paul Baran all elected to **Silicon Valley Hall of Fame**.

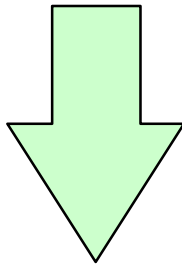




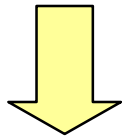
Todd Young  
Director of Product and Business Development  
Rosum Corporation  
tyoung@rosum.com  
650.230.7341



## GPS Power Levels



➤ Design Signal Level for L1 signal at Earth's surface is a minimum of  $-130\text{dBm}$ , typically the power level is  $-127\text{dBm}$ .



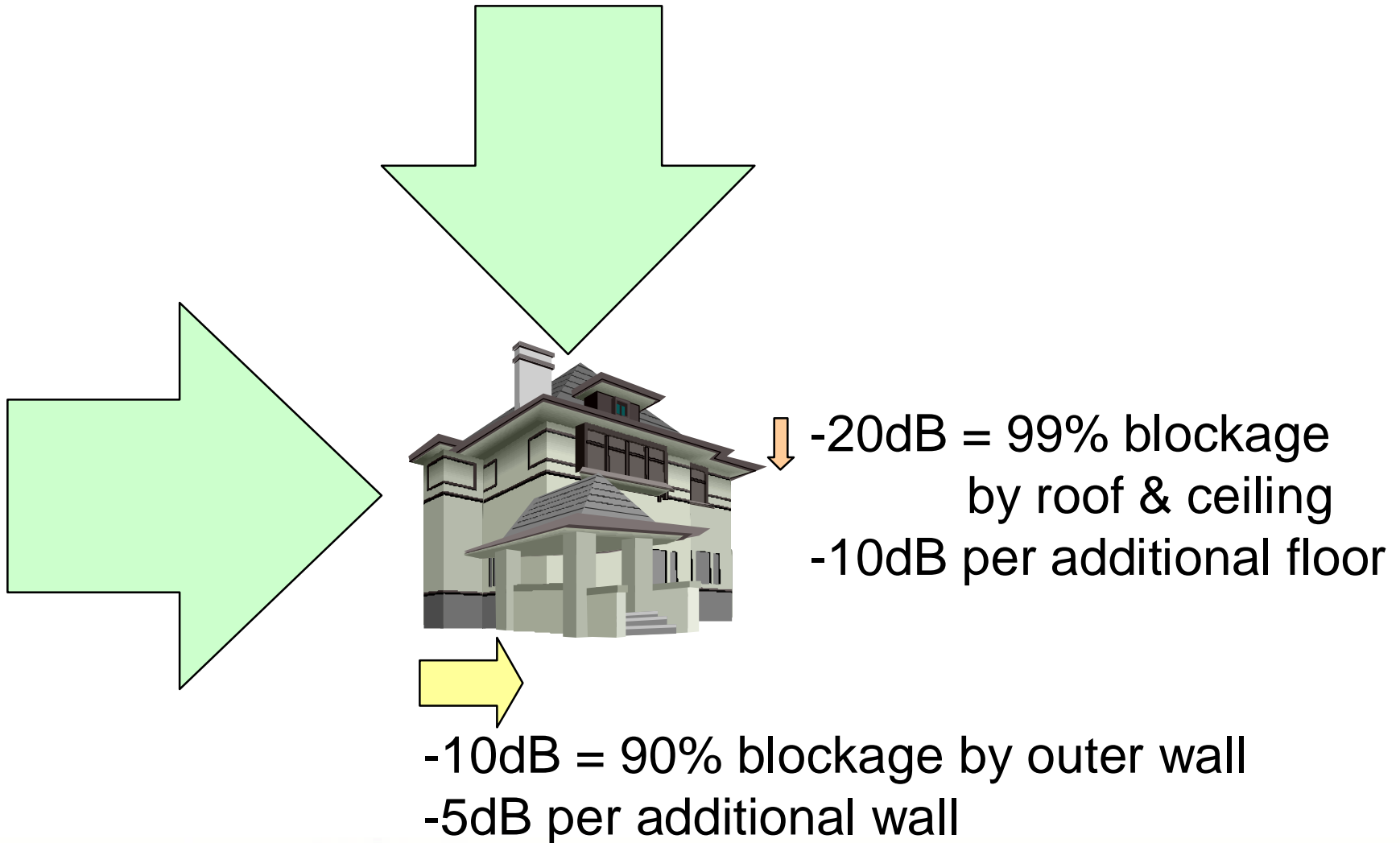
➤  $-142\text{dBm}$  is the low end of what can be received when the navigation message must be decoded.



➤  $-160\text{dBm}$  is the low end of what can be tracked, once the signal is found.



# Residential Signal Blockage





# Commercial Building Signal Blockage

