

# Marketing v. Reality in Multi- Antenna Wi-Fi

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Guide to Beamforming  
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Scott Reeves

Technical Director  
EMEA



# Summary

- Wi-Fi vendors are marketing chip-based beamforming more heavily
- They gloss over limitations, naturally
  - Mutually-exclusive chip-based beamforming and spatial multiplexing
  - Zero gain from implicit beamforming, minimal (2 dB) from explicit
  - Zero client support today for explicit
- Customers are easily confused, since all beamforming sounds the same to any non-specialist
- A back-to-the-basics view (focusing on simple but technically accurate descriptions how multi-antenna techniques really work) can cut through the confusion
- ...and illustrate why Ruckus BeamFlex remains the superior approach

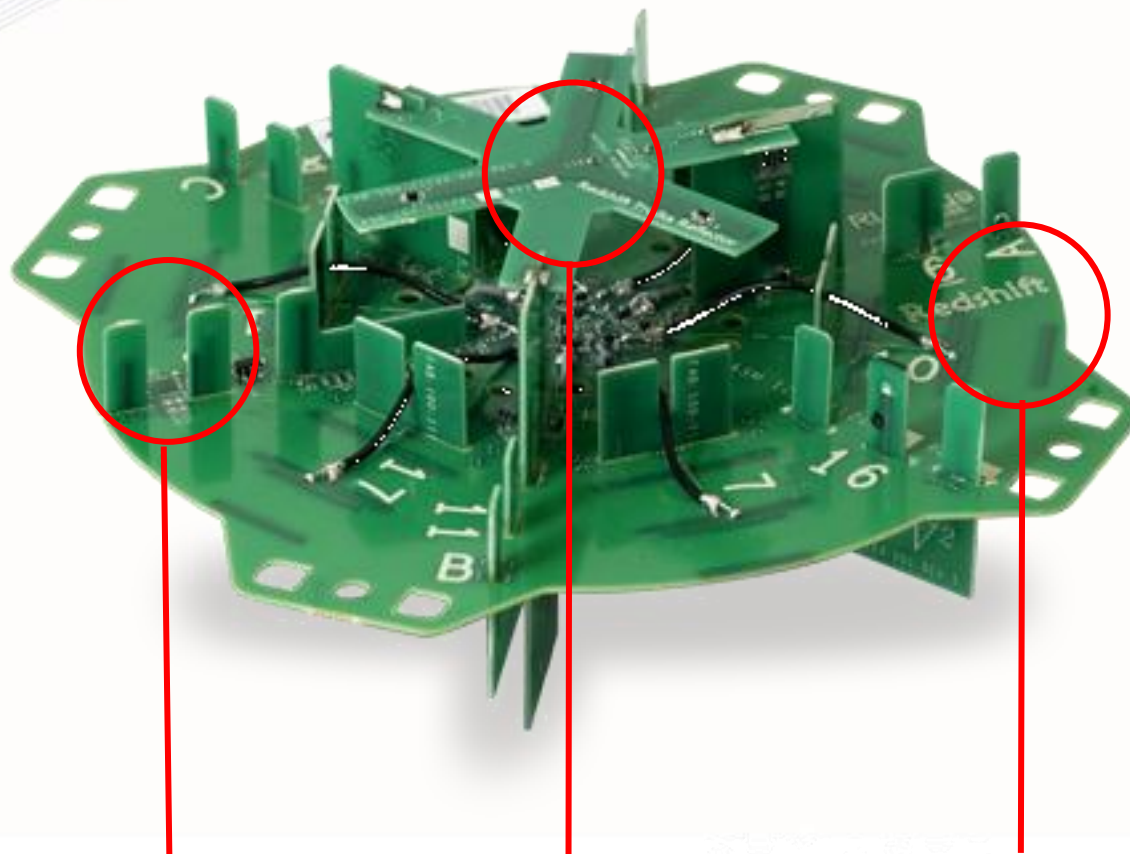
# Conventional Wi-Fi: omni Tx pattern



Omni  
Transmit (Tx)  
Pattern



# BeamFlex Smart Antennas



Vertically -polarized  
antenna  
elements

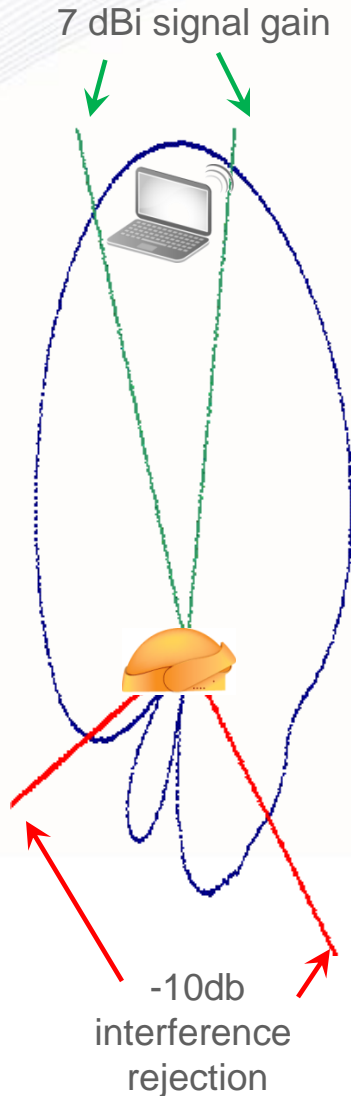
Auto  
RF signal  
optimizer  
(Optimises RF coverage based on device  
orientation)

Horizontally-  
polarized  
antenna  
elements



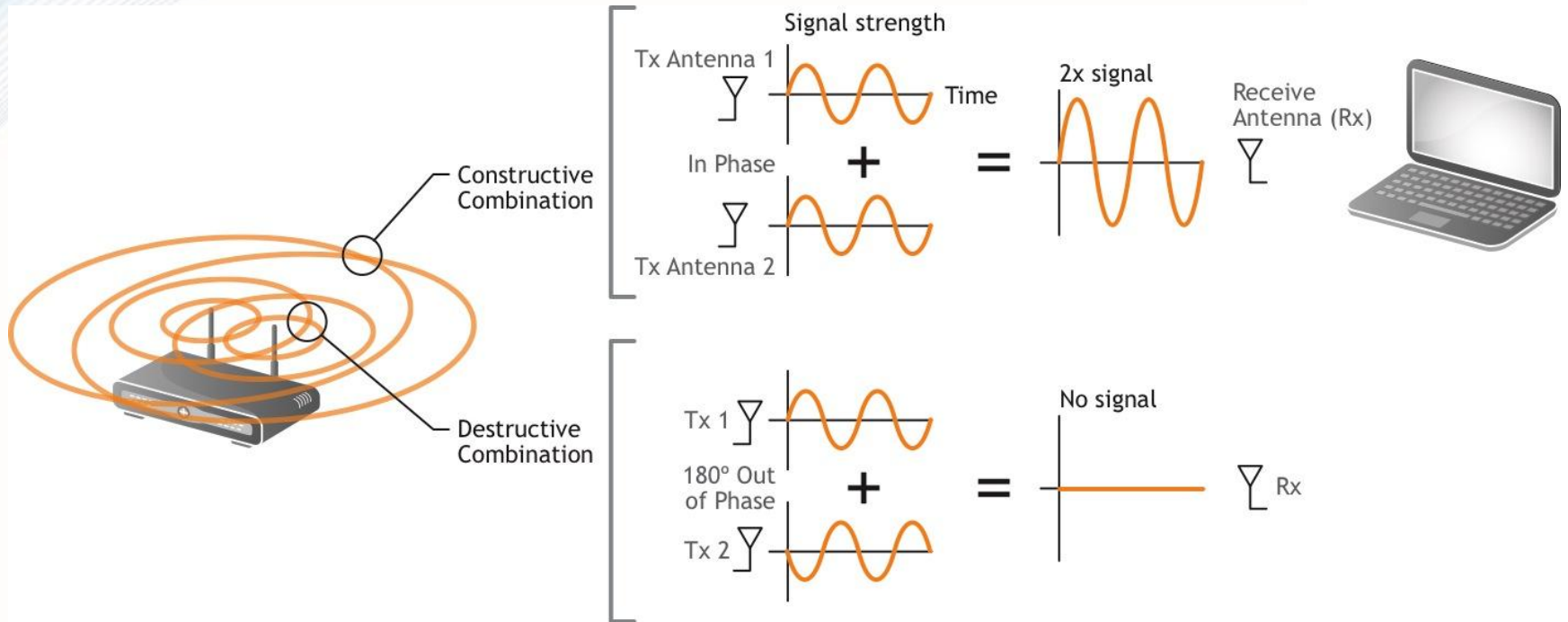
# Automatic Interference Mitigation (AIM)

*Interference Rejection is Essential*



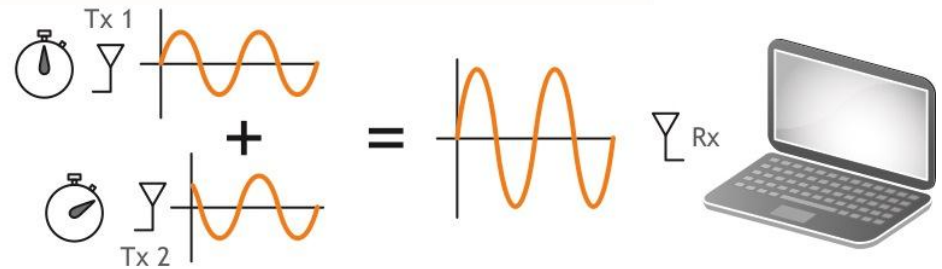
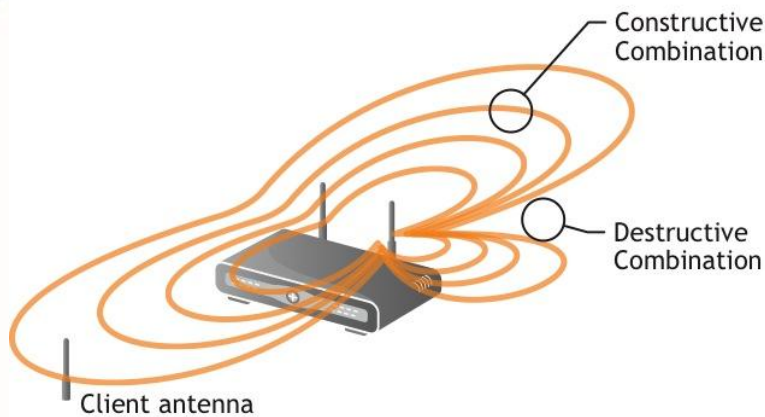
- Chip-based beamforming has no mechanism to reject interference
- Omni-directional antennas can't ignore interference
- BeamFlex mitigates interference by positioning antenna nulls in specific directions
- Negating interference can be more beneficial than signal gain

# Key concepts: combination and phase



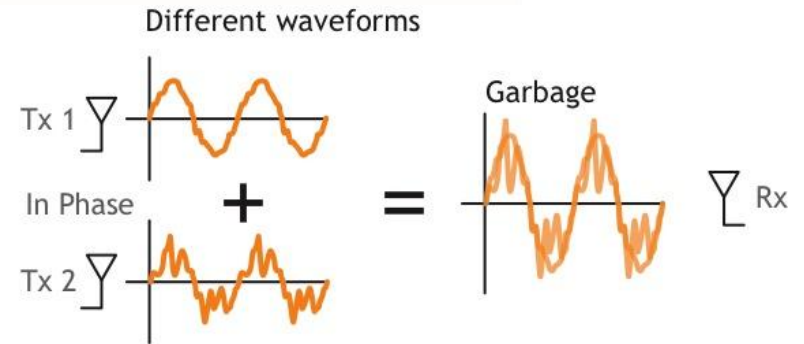
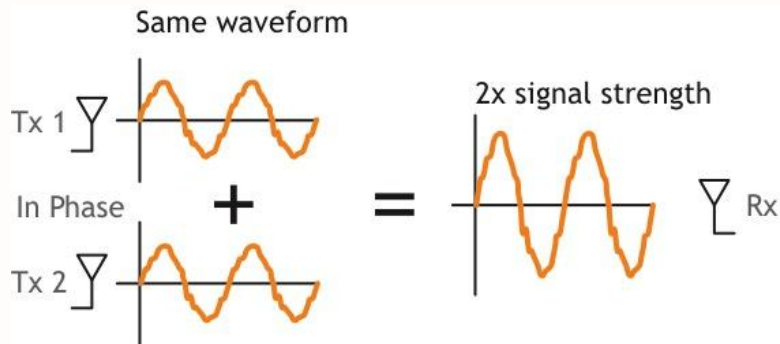
# How chip-based beamforming works

Understanding the narrow definition of the term “beamforming”



Phase adjustment per antenna to direct location of constructive combination on client

# Beamforming: only one signal allowed





# Chip Based Beamforming Limitations

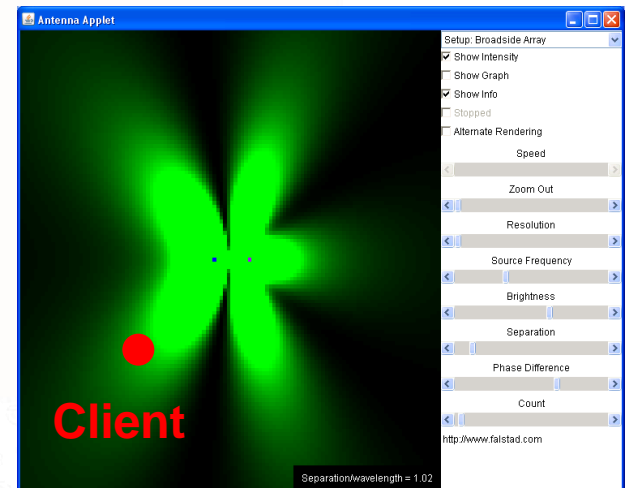
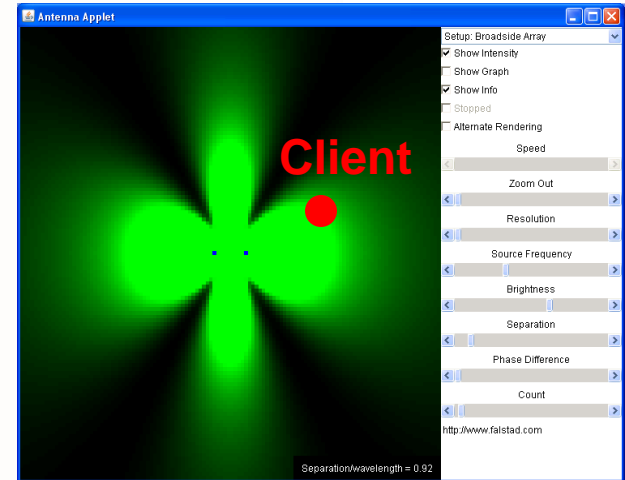


- Generates unwanted interference and wastes energy
- No way to cope with real-time interference at the client
- Beams predicated on antenna separation



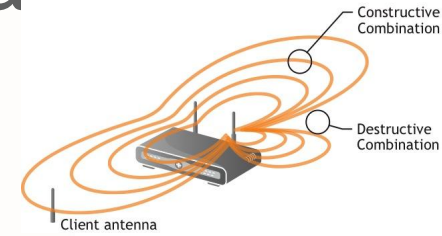
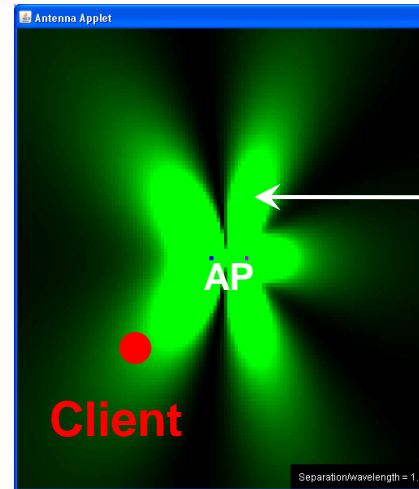
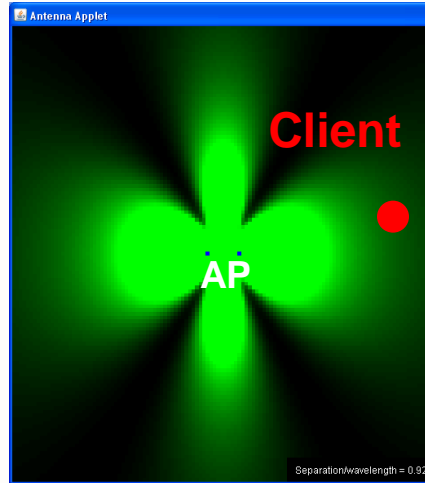
Optimal beamforming (5GHz) calls for .5" antenna separation

Optimal spatial multiplexing "requires" antenna separation at inches (5GHz)



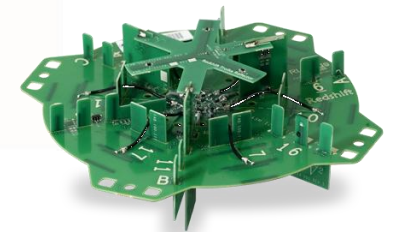
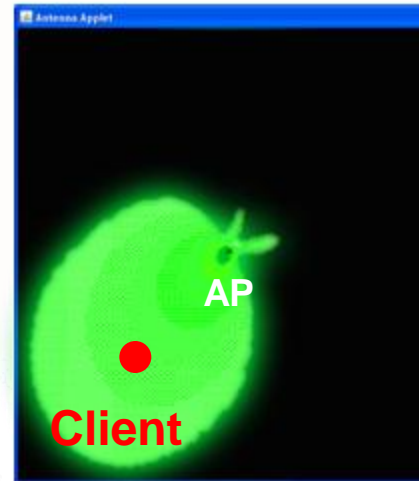
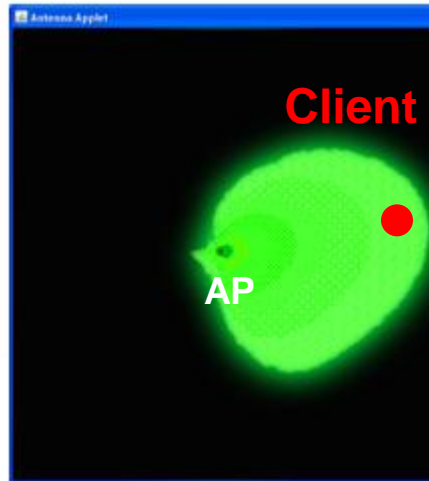
# Not All Beams Are Created Equal

Antenna Pattern  
Example:  
Chip-based  
beamforming



- Wasted RF energy
- Added interference

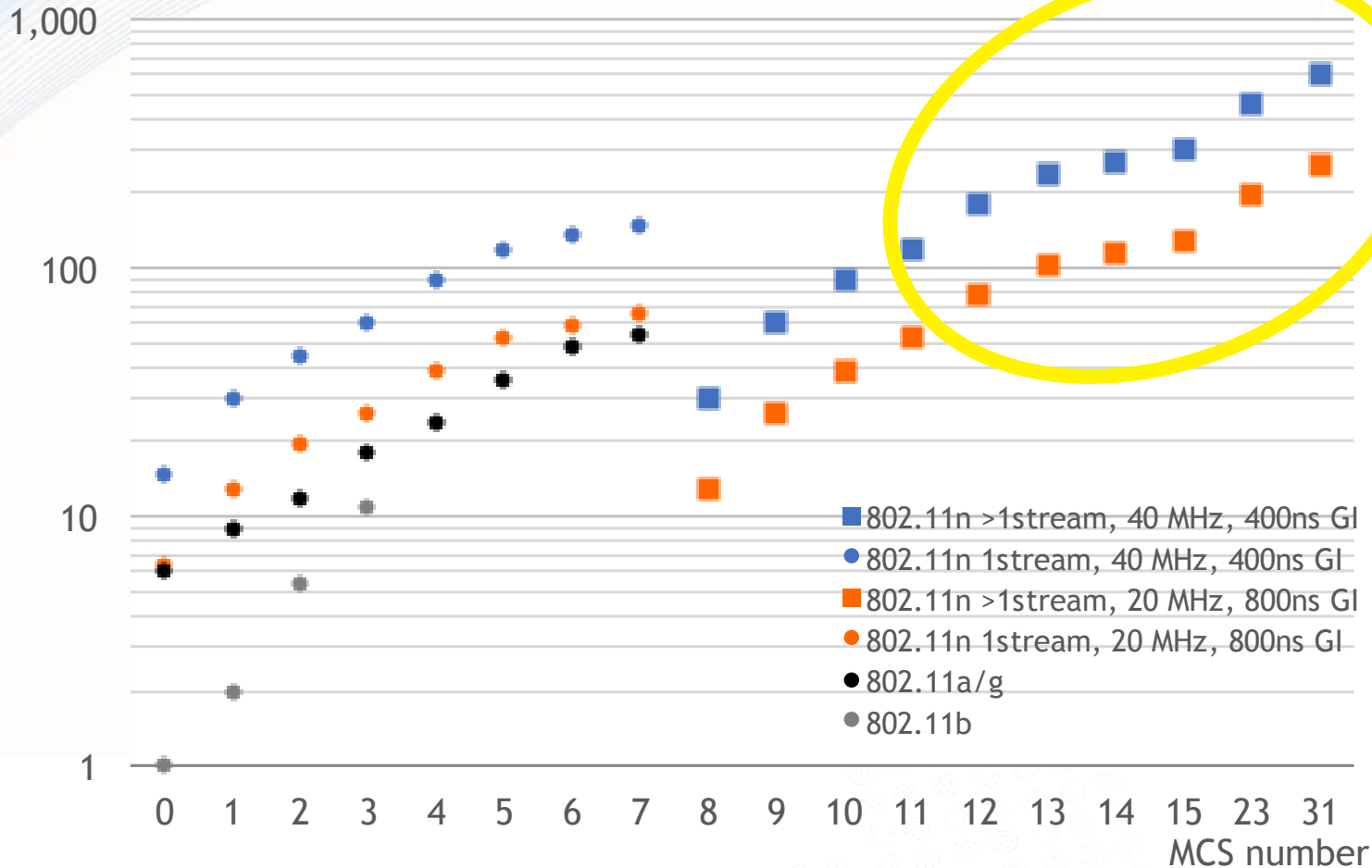
Antenna Pattern  
Example:  
Antenna-based  
beamforming



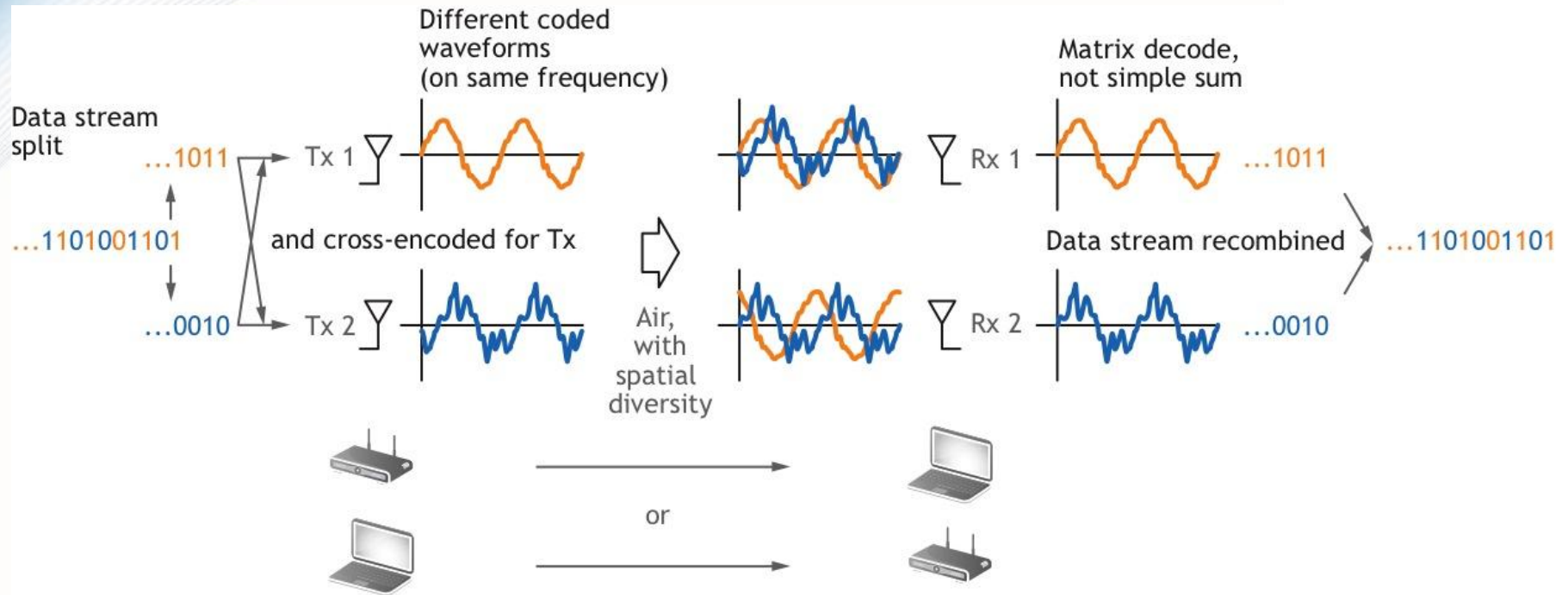
# Spatial multiplexing is essential

Speeds in the 802.11 protocols

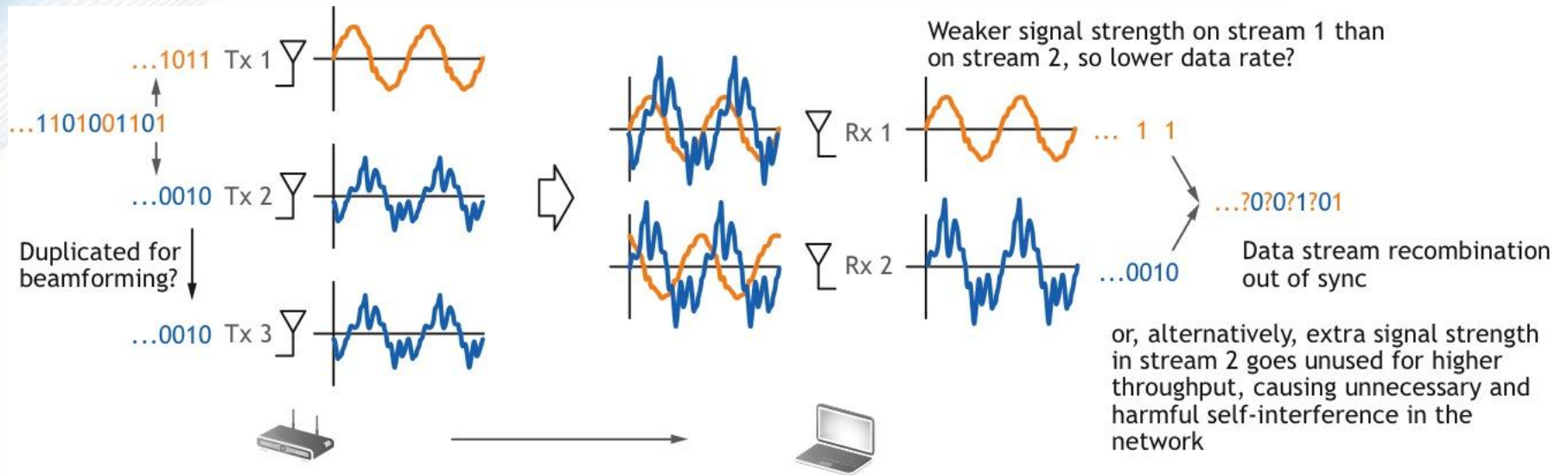
Peak bit rate, Mbps



# How spatial multiplexing works



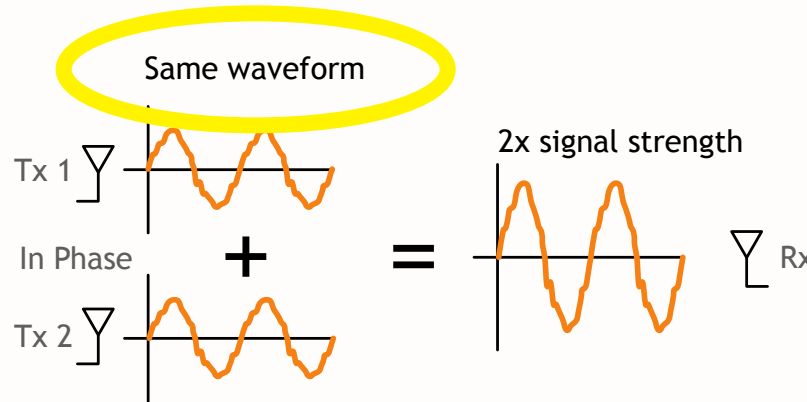
# Why 3 radio chains don't help



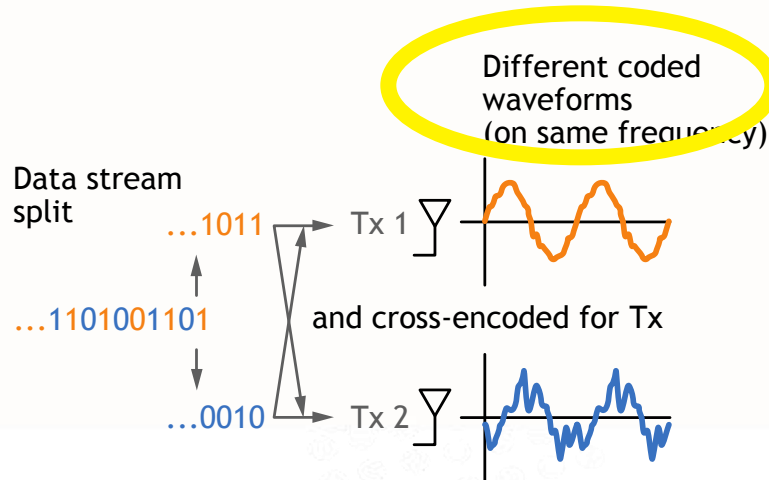
# SM and chip BF are mutually exclusive

(With 1 radio chain per stream)

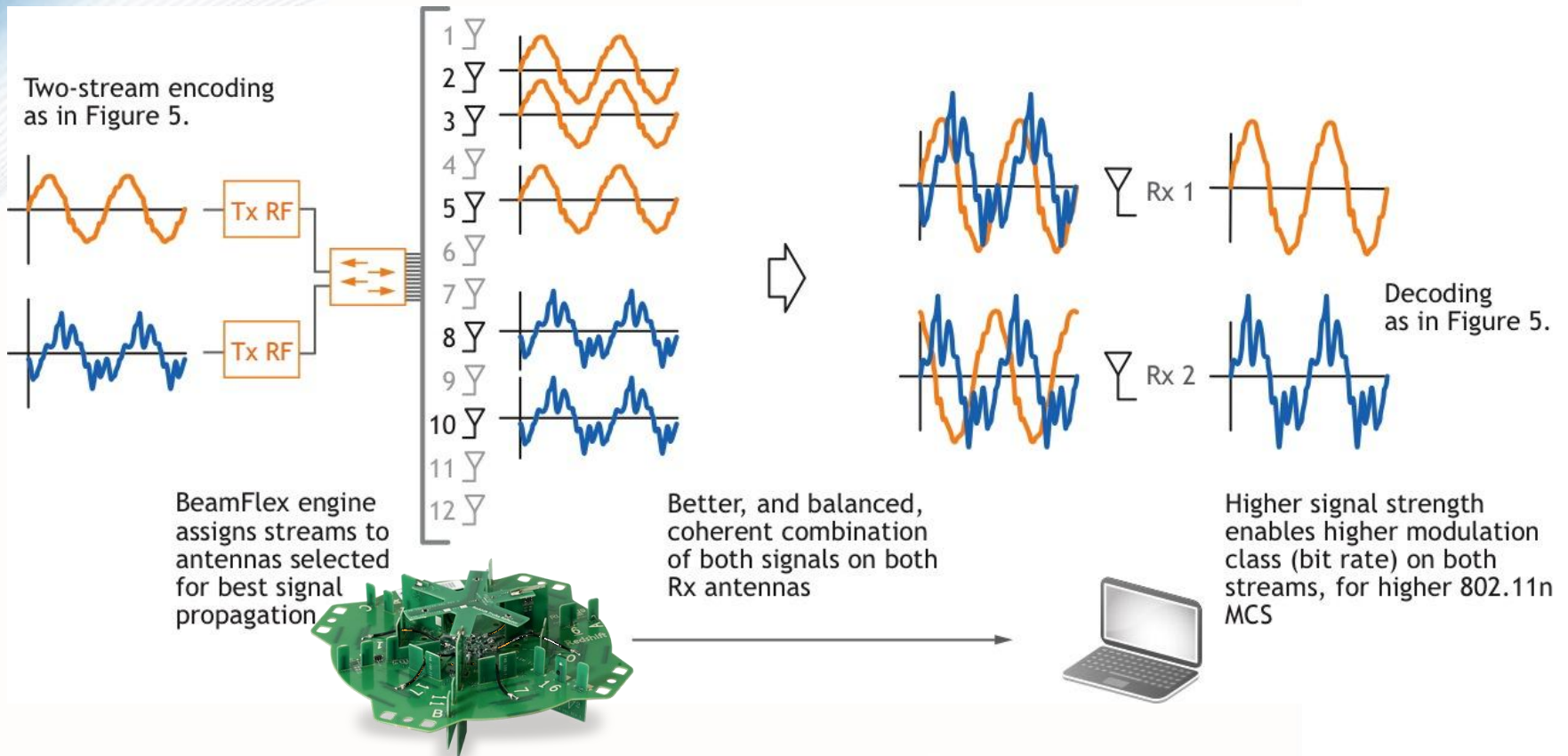
Chip-based beamforming



Spatial multiplexing



# BeamFlex + spatial multiplexing



# A proper multi-antenna taxonomy

Attributes	Implicit Beamforming	Explicit Beamforming	BeamFlex Adaptive Antennas
802.11 protocols supported	a, b, g, n	n	a, b, g, n
adaptation	effectively open loop (uses guesswork based on uplink)	closed loop	closed loop
client behavior requirement	none	must send AP transmit characteristics 'recommendation'	none
source of feedback	measurement of uplink signal from client	client's recommendation	client ACK packet on previous transmission
supports 802.11n spatial multiplexing	NO*	NO*	YES
typical performance gain (see section 6)	none	2 dB	6 dB
network self-interference reduction	none	none	10-15 dB
vendor examples	Cisco, Meraki	HP	Ruckus

\*would require 2 or more radio chains and antennas per spatial stream, a configuration no commercial AP supports today

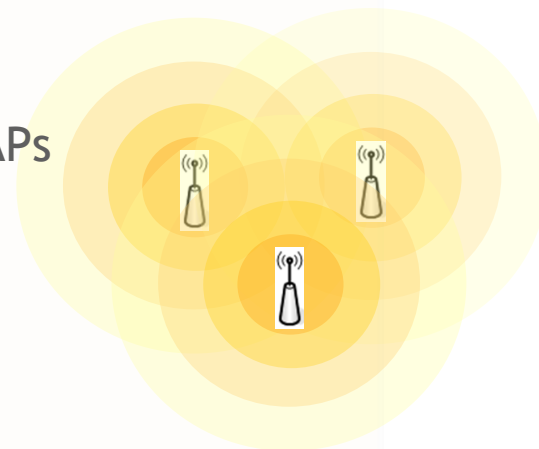




# BeamFlex Antenna Advantages

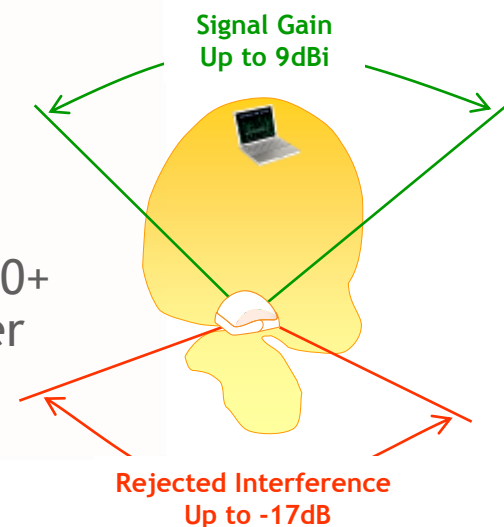
- **Omni-directional antenna:**

- ✗ Cannot control interference to neighbouring APs
- ✗ Multipath phasing can be a significant issue
- ✗ No interference rejection
- ✗ Make bad RF neighbors



- **BeamFlex smart antenna:**

- ✓ Beamforming focuses the RF energy ensuring multipath arrives in phase and provides maximum signal density = extended range and superior performance
- ✓ Horizontally and vertically polarised elements offer 4000+ unique antenna patterns automatically selected on a per packet/per client basis
- ✓ Attenuate interference from adjacent APs, clients and other RF sources
- ✓ Cause significantly less interference to adjacent APs

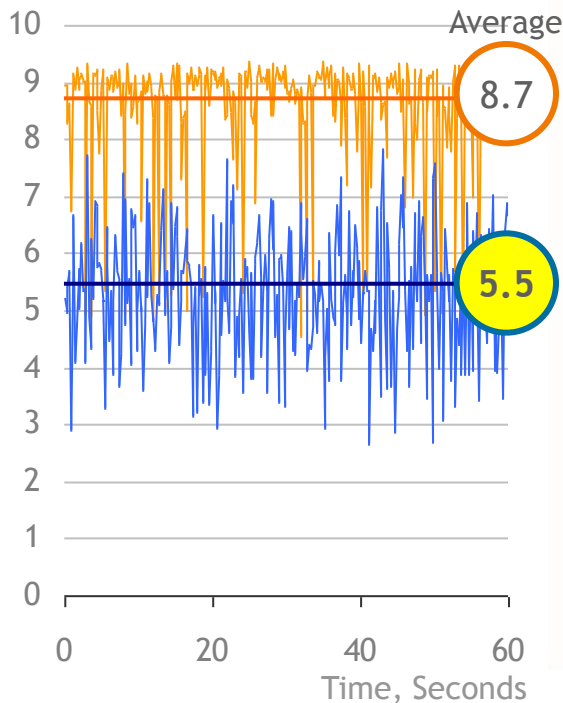


# BeamFlex™: Interference Resistance

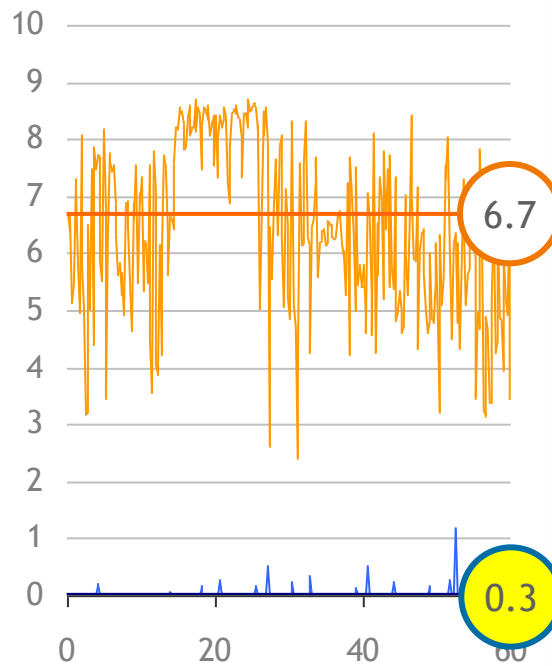
## iPhone 3G Client Throughput Comparison

### Ruckus

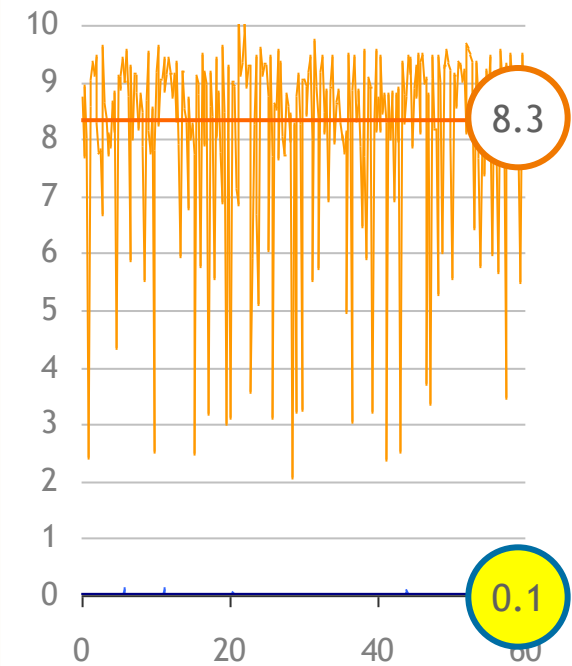
Throughput, Mbps



### Vendor B



### Vendor C

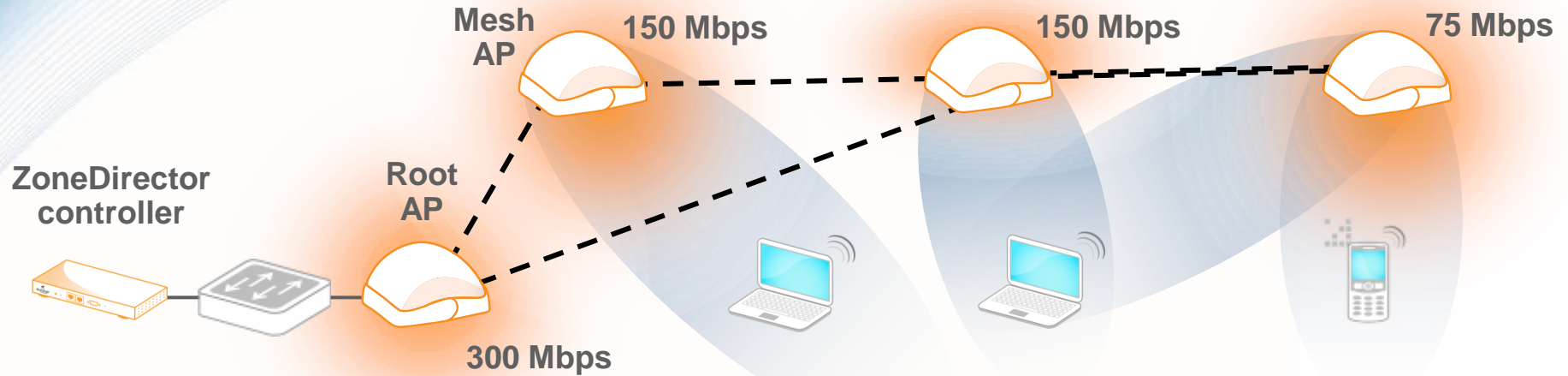


- Test House Baseline (low interference)
- High Interference Location (191 active APs in 3,000m² facility)



## SmartMesh:

# Meshing with Adaptive antenna beamforming

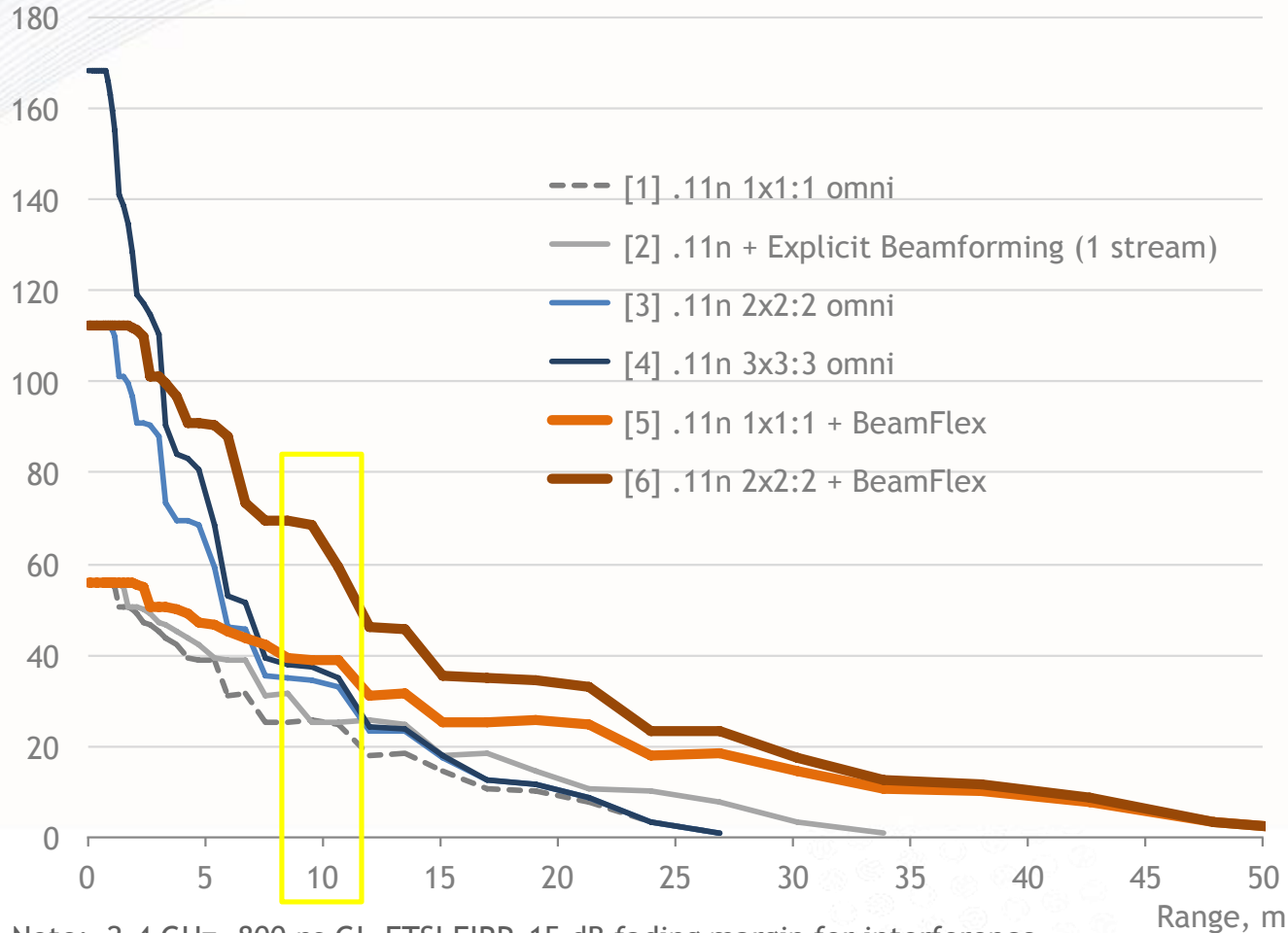


- Mesh-APs continuously announce their link capacity
- Each Accesspoint selects the best path to Root-AP
- BeamFlex optimizes the signal quality to clients & mesh-APs
- Self-healing in case of an outage of a mesh-node (also to an alternate Root AP possible)

# Performance varies significantly

## RF Technology Comparison

Peak Throughput, Mbps

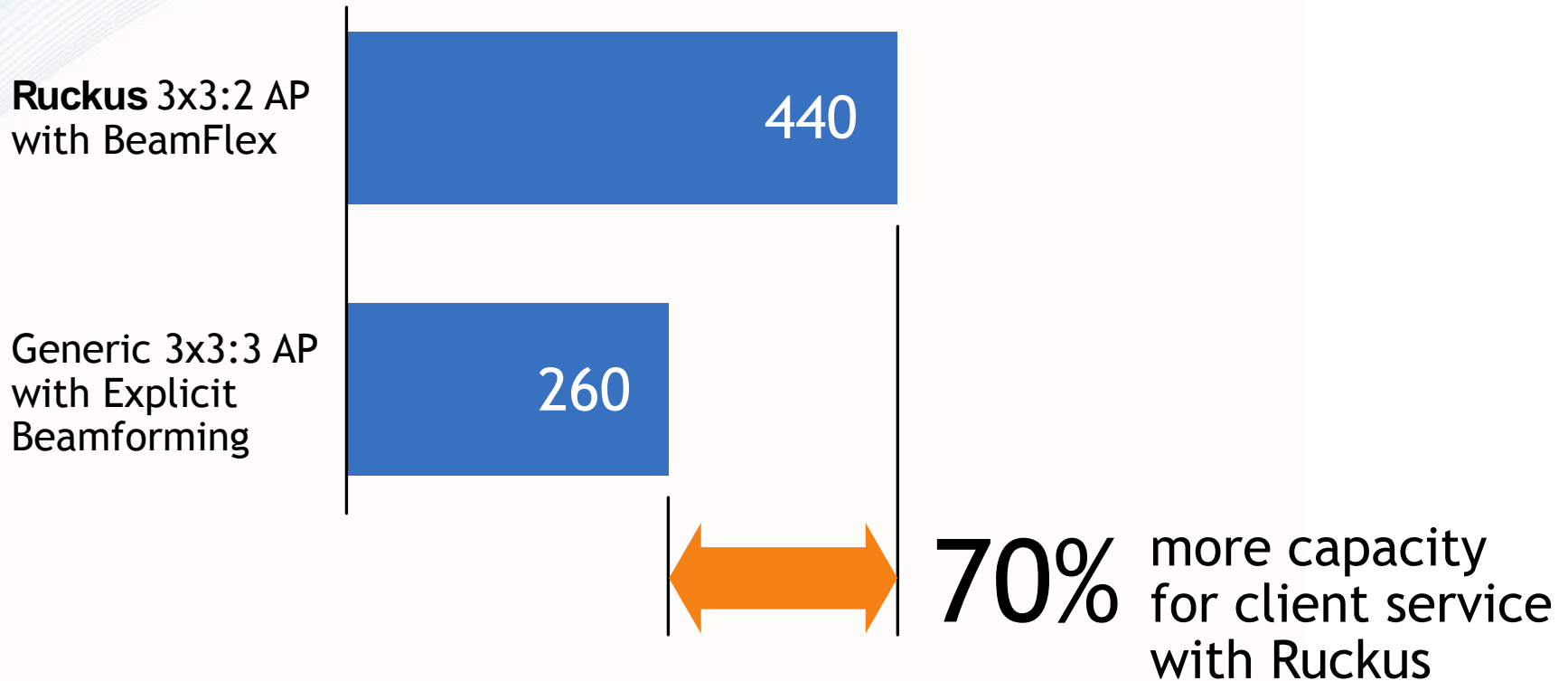


Note: 2.4 GHz, 800 ns GI, ETSI EIRP, 15 dB fading margin for interference and obstructions

Sources: Ruckus testing, experience.

# Net result: BeamFlex 70% better

4-Year Aggregate Client Throughput per AP, Terabytes



# Case Study

Wireless Broadband Deployment

Tikona India

# The World's Largest Wireless Mesh

*Based on Ruckus Wireless Product and Technology End-to-End*

- Began build out in 2009
- 40,000 smart mesh APs now deployed and operational (50k by 2011)
- Hundreds of smart WLAN controllers
- Central management through FlexMaster
- Hundreds of thousands of users

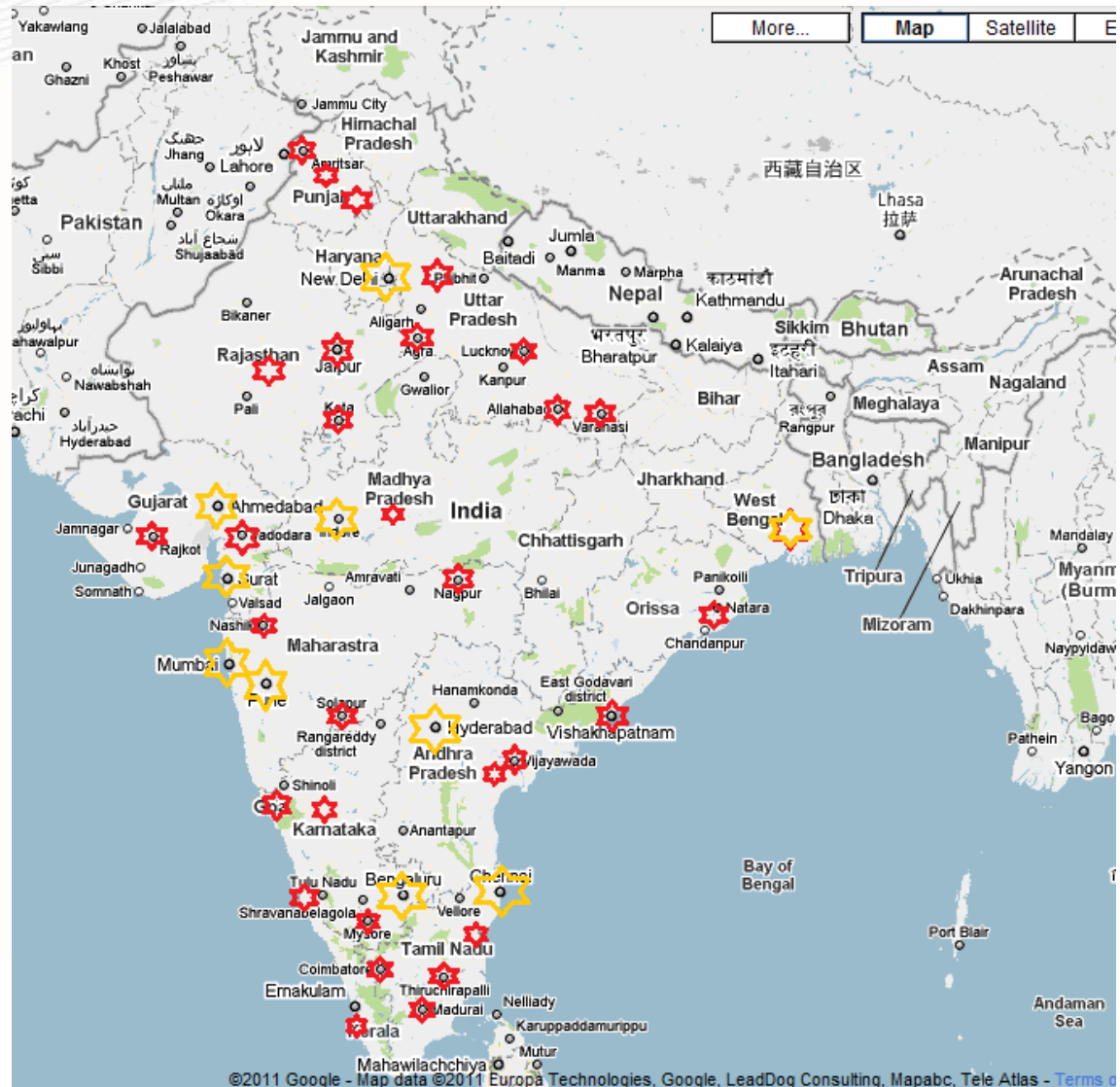


802.11g outdoor AP to indoor CPE data rates 1,670 samples on live Tikona network



# Tikona footprint

- 40,000 AP live
- 45,000 AP deployed (approximately)





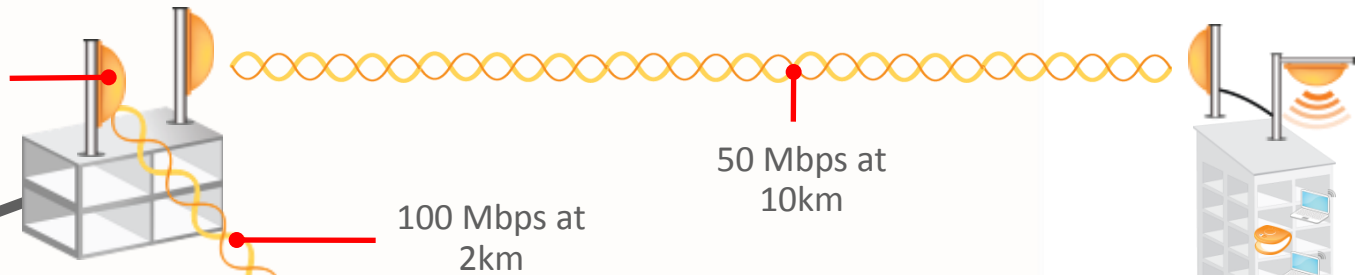
# Large-Scale Mesh Deployment



Digital Networks

## ZoneFlex 7731

Point-to-point  
802.11n backhaul



100 Mbps at  
2km

50 Mbps at  
10km

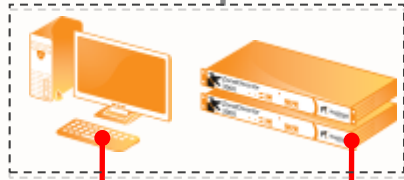
Broadband  
Network

Backhaul  
POP

## Outdoor Mesh AP

20 Mbps at  
300m/1000 ft

NOC



## ZoneDirector

WLAN Controller

## FlexMaster

Remote Management

## MediaFlex 2211

Bridge/Repeater



# End-to-end visibility and control



2009/12/13 23:11:02 | Help | Log Out (admin@ruckus.com)

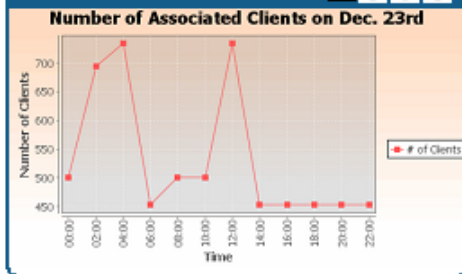
MAC or IP or Name

**Dashboard** | Inventory | Configure | Monitor | Reports | Administer

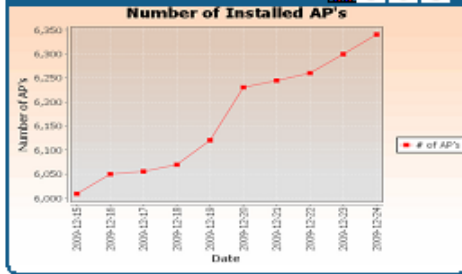
## Zone Director Device View

View	ZDs	APs	Root APs	Mesh APs	Link APs	Clients	Events
All Zone Directors	<a href="#">127</a> / <a href="#">2</a>	<a href="#">10230</a> / <a href="#">20</a>	<a href="#">3852</a> / <a href="#">0</a>	<a href="#">3818</a> / <a href="#">0</a>	<a href="#">2559</a> / <a href="#">0</a>	<a href="#">8224</a>	<a href="#">Events</a>
All Primary ZDs	<a href="#">121</a> / <a href="#">2</a>	<a href="#">10228</a> / <a href="#">17</a>	<a href="#">3851</a> / <a href="#">0</a>	<a href="#">3817</a> / <a href="#">0</a>	<a href="#">2559</a> / <a href="#">0</a>	<a href="#">8216</a>	<a href="#">Events</a>
All Failover ZDs	<a href="#">4</a> / <a href="#">1</a>	<a href="#">0</a> / <a href="#">4</a>	<a href="#">0</a> / <a href="#">0</a>	<a href="#">0</a> / <a href="#">0</a>	<a href="#">0</a> / <a href="#">0</a>	<a href="#">0</a>	<a href="#">Events</a>
Primary ZD Mumbai	<a href="#">50</a> / <a href="#">0</a>	<a href="#">4708</a> / <a href="#">87</a>	<a href="#">2367</a> / <a href="#">0</a>	<a href="#">1528</a> / <a href="#">0</a>	<a href="#">812</a> / <a href="#">0</a>	<a href="#">4023</a>	<a href="#">Events</a>

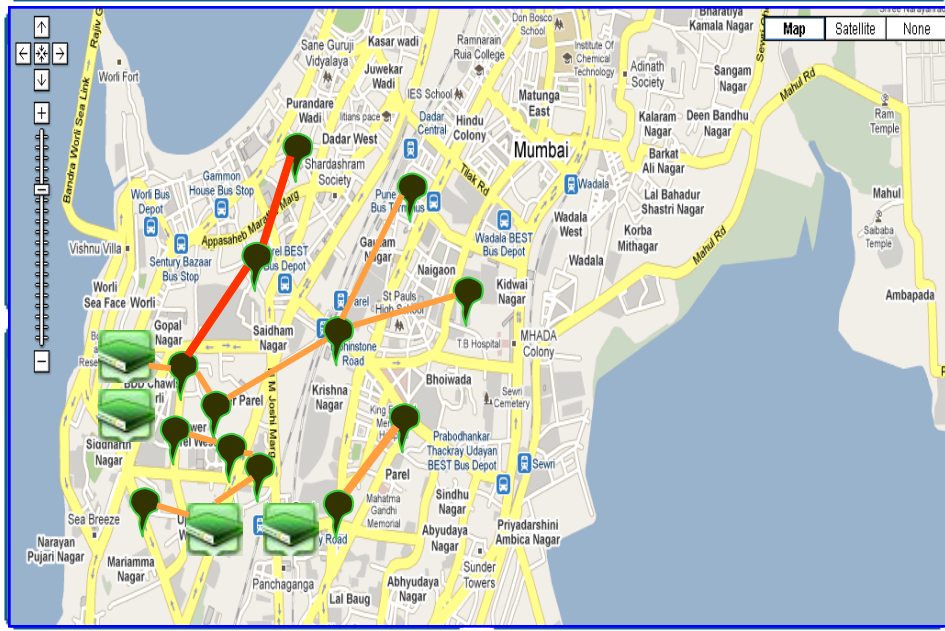
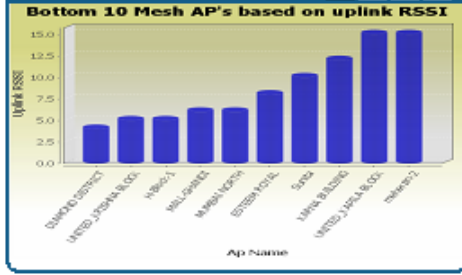
## Client Connectivity



## Connectivity



## Bottom 10 Mesh AP (RSSI)

















[Manage Widgets](#)

- One NOC
- Multiple cities
- Tens of Thousands of access points
- Hundreds of Thousands of clients



# Active Antenna Beamforming Wi-Fi Portfolio

*Autonomous, Controller-Based or Remotely Managed*

<p>802.11 n AP</p>  <p>802.11n Bridge</p> 	<p>2X2 dual-band 802.11n</p>  <p>Single-band 802.11n</p>  <p>802.11n wall switch</p>  <p>802.11g</p> 	<p>Dual-band 802.11n outdoor</p>  <p>802.11g outdoor mesh</p>  <p>3X3 dual-band 802.11n</p> 	<p>Strand-Mounted 802.11n</p>  <p>Sectorized dual-band 802.11n</p>  <p>Dual-band 802.11n outdoor</p>  <p>802.11g outdoor mesh</p> 	<p>5GHz 802.11n PtP/PtMP</p> 
<p style="text-align: center;"><b>I N D O O R</b></p>			<p style="text-align: center;"><b>O U T D O O R</b></p>	



## Network and Subscriber Management

### ZoneDirector™



Smart Wi-Fi controllers for RF and AP management

### FlexMaster™



Highly-scalable centralized network and element management



# Thank You

Scott Reeves

Technical Director EMEA

Ruckus Wireless

[Scott@ruckuswireless.com](mailto:Scott@ruckuswireless.com)