Mobile Experts:

We provide market analysis

Focused on the Radio Chain in Handsets and Base Stations

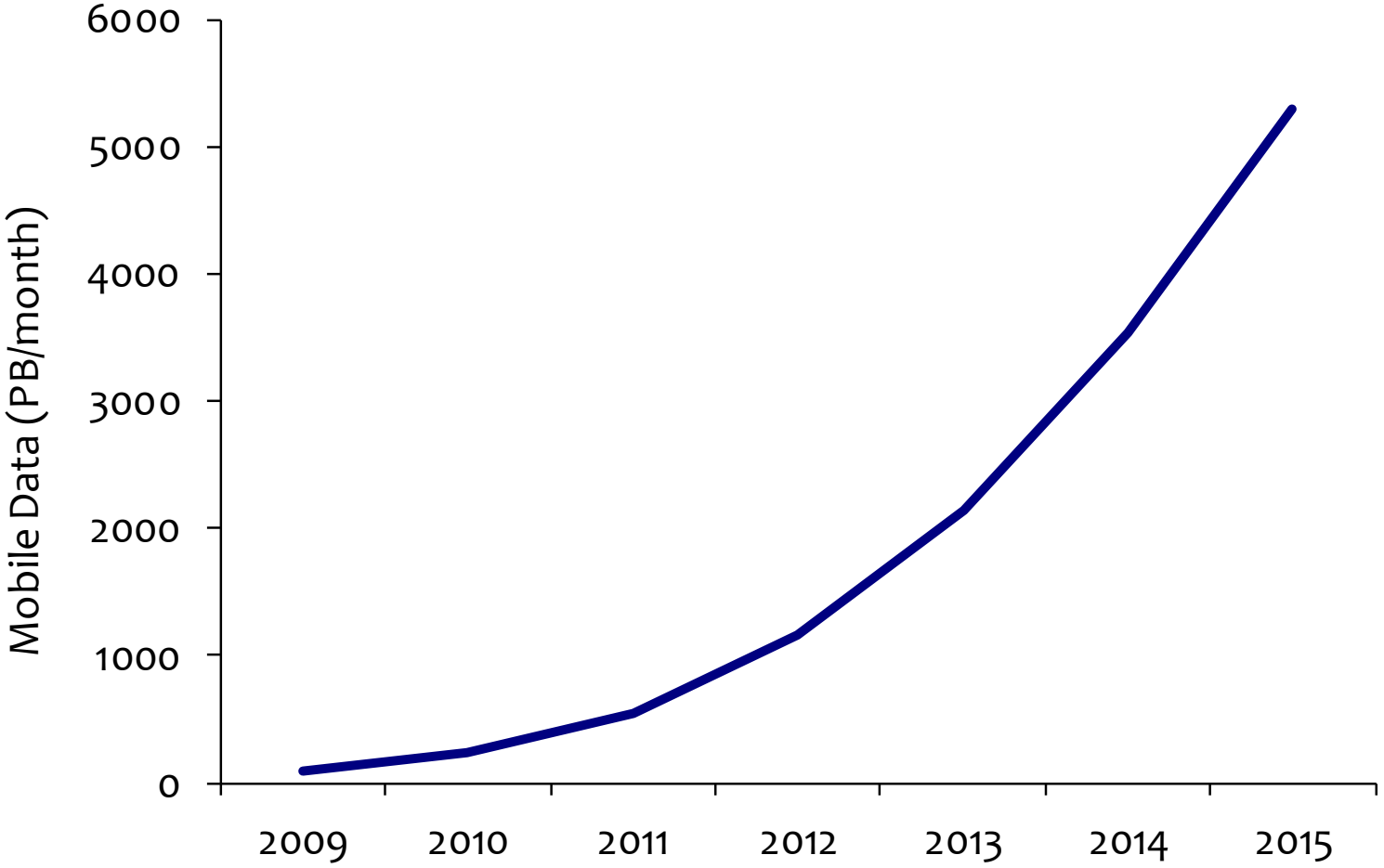
MOBILE EXPERTS

Mobile Experts--projects

- Link Budget and Throughput Study for Verizon Wireless LTE deployment
- Handset RF power analysis for battery life modeling, for Verizon Wireless and IWPC Consortium
- Tear-down studies of base station radios
- Market Research Reports:
  - *Semiconductors for Remote Radio Heads*
  - *In-Building Wireless Markets*
  - *Outdoor Distributed Antenna Systems (DAS)*
  - *Femtocell Field Trial Results*
  - *Multi-Standard Radio Base Stations*

MOBILE EXPERTS

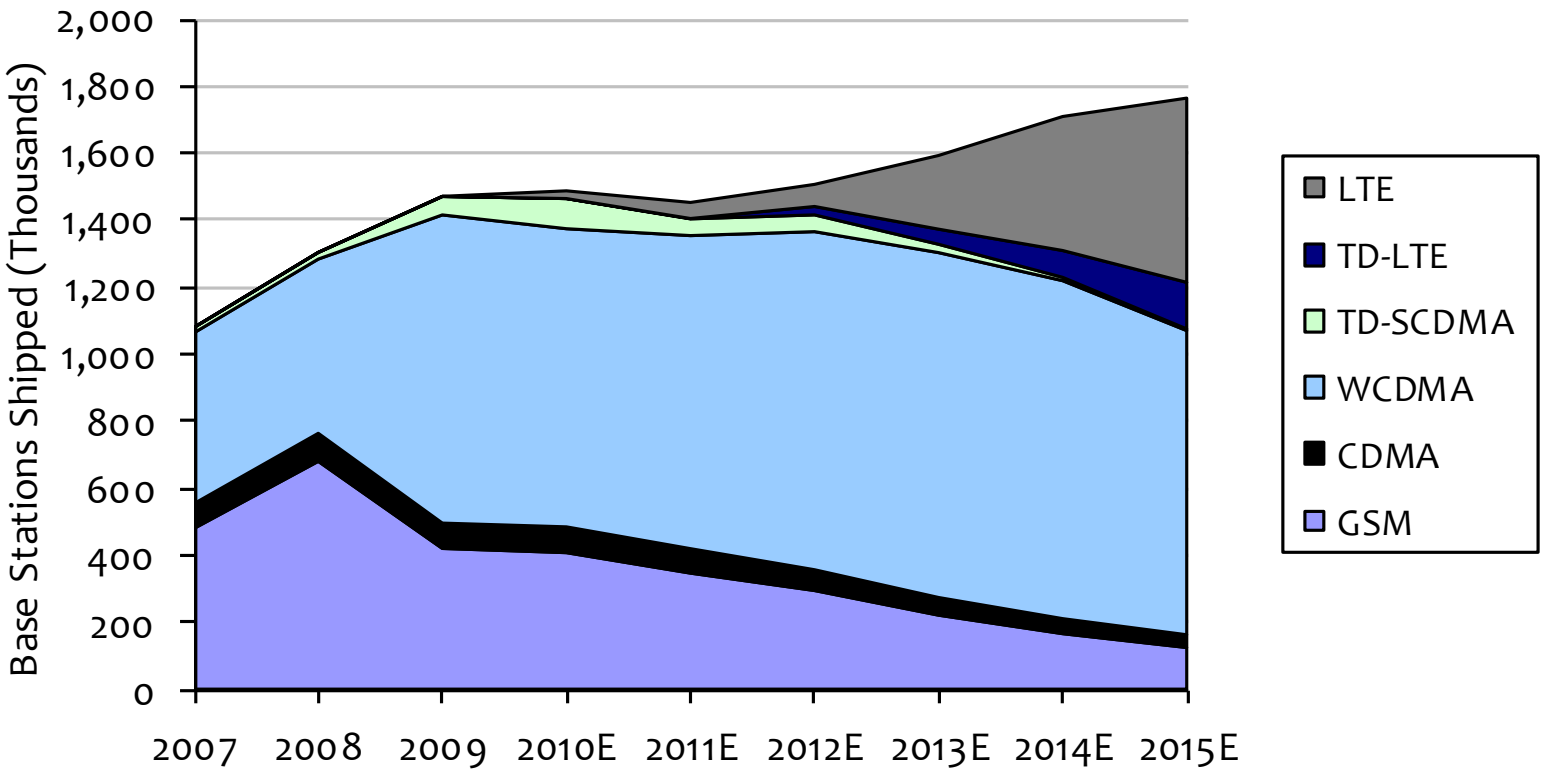
Mobile Data Growth



- Mobile Data is growing *fast*
- Operators have problems with bottlenecks *now*
- *The future is scary for mobile operators!*

MOBILE EXPERTS

Mobile Infrastructure Market



- WCDMA/HSPA are driving strong numbers; LTE is starting
- Base Stations must support 2G, 3G, and LTE simultaneously

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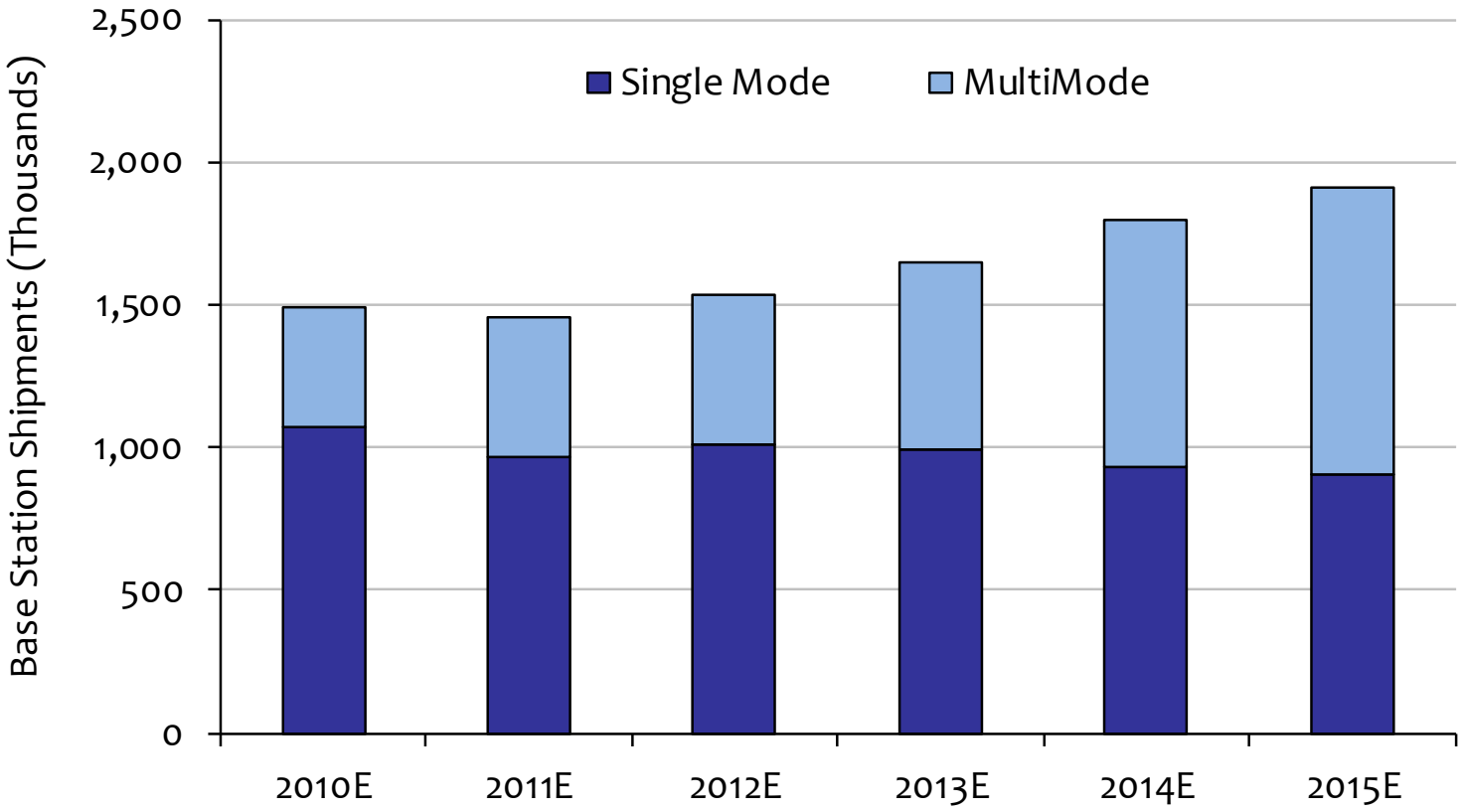
Multi-Standard Radio Base Stations



- The market is moving to multi-mode radio designs
- Cost is limiting the market from wholesale conversion to multimode

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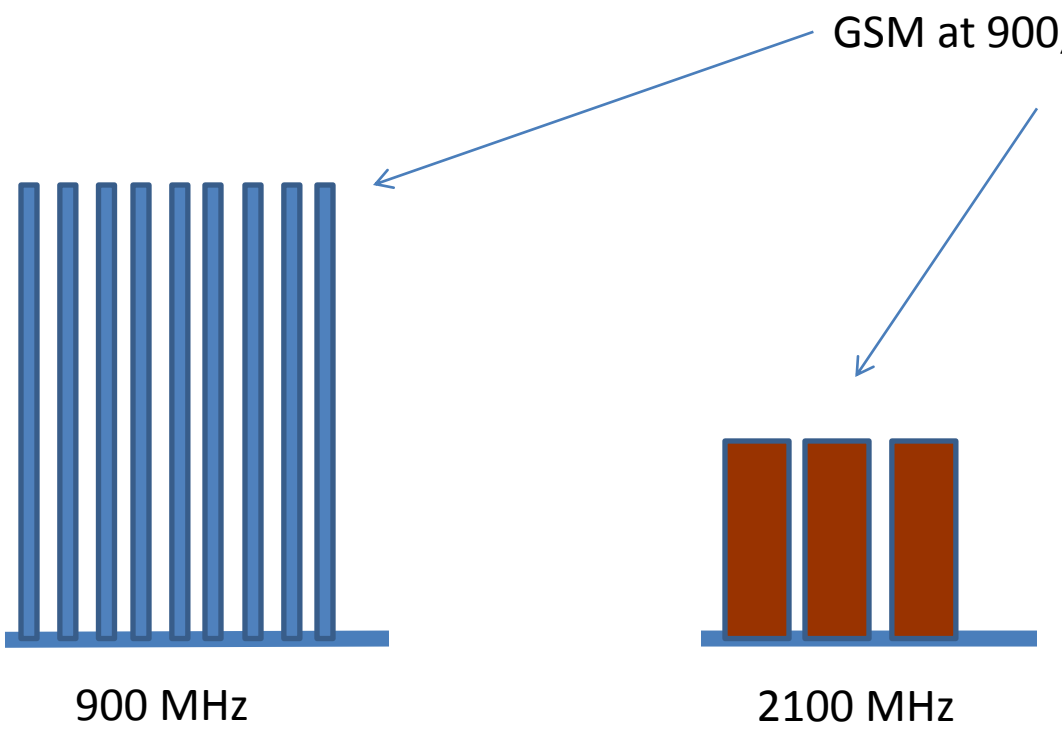
Why multi-mode?
It's all about uncertainty

- What air interface will I need in the future?
- What standards changes are coming next?
- Will enough LTE spectrum be available?
- Will my LTE spectrum support the required building penetration and range?
- Should the network optimize for mobility, or for throughput? Coverage or capacity?

MOBILE EXPERTS

Spectrum Migration



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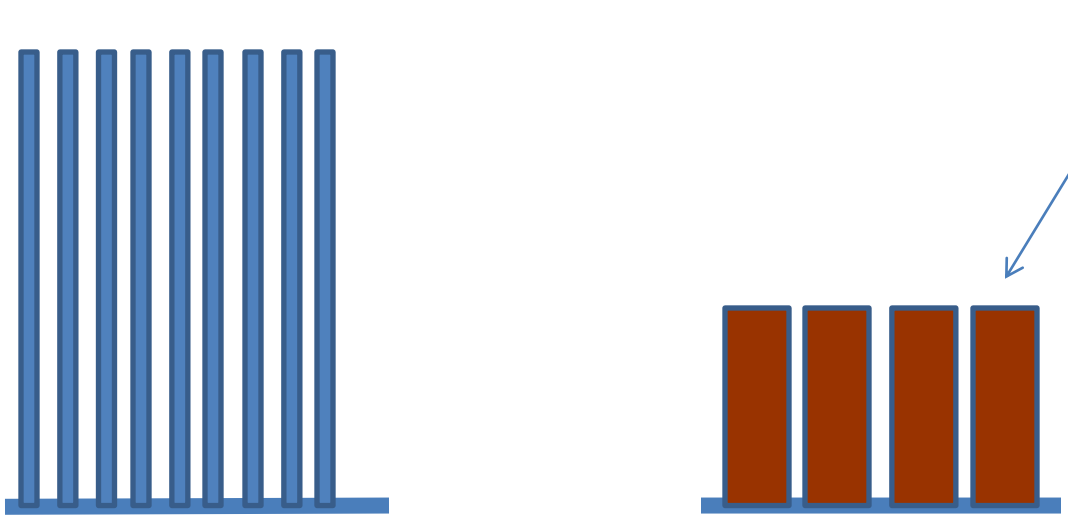
Spectrum Migration

Add an HSPA channel at 2100 MHz



900 MHz

2100 MHz

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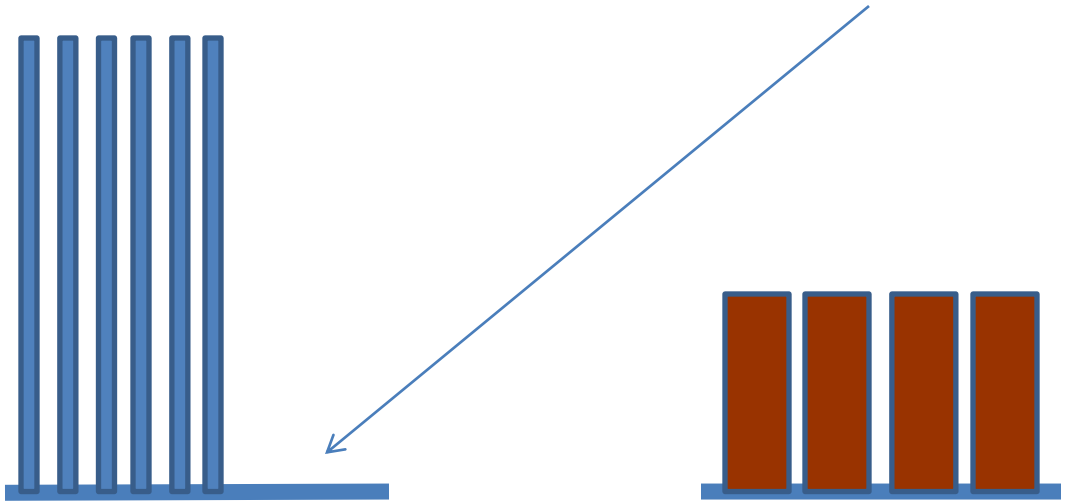
Spectrum Migration

Clear some spectrum at 900 MHz

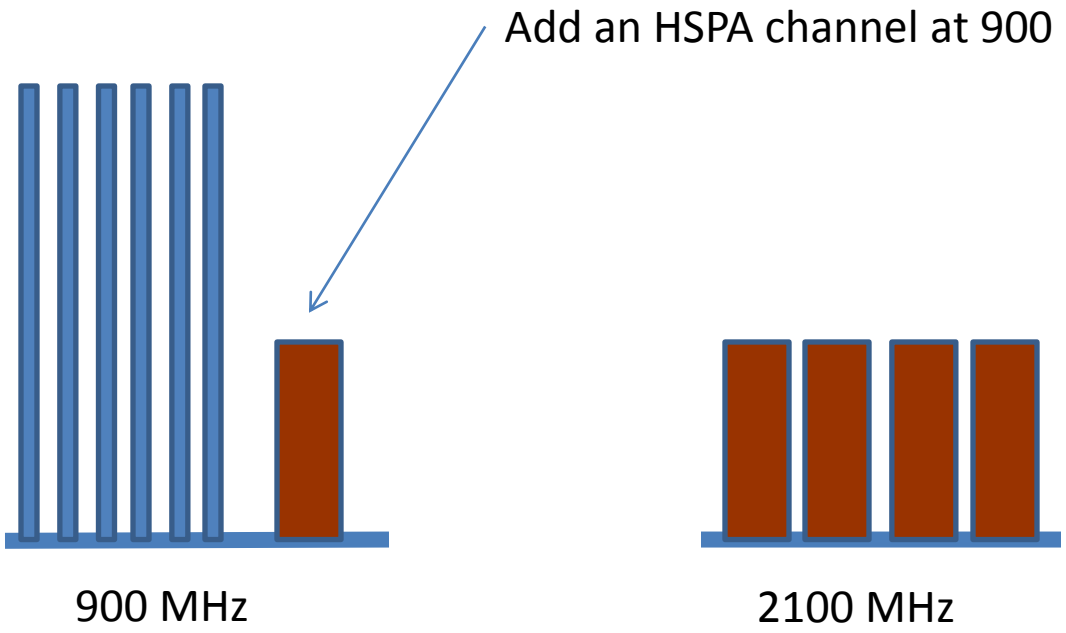


900 MHz

2100 MHz

MOBILE EXPERTS

Spectrum Migration



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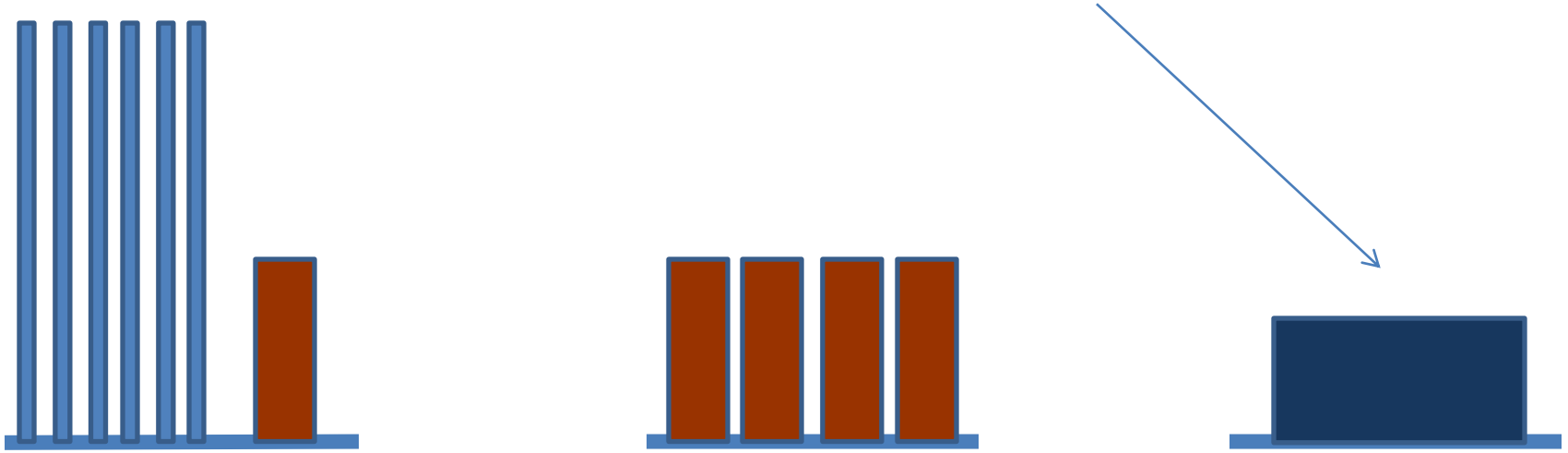
Spectrum Migration

Add an LTE channel at 2600 MHz



900 MHz

2100 MHz

2600 MHz

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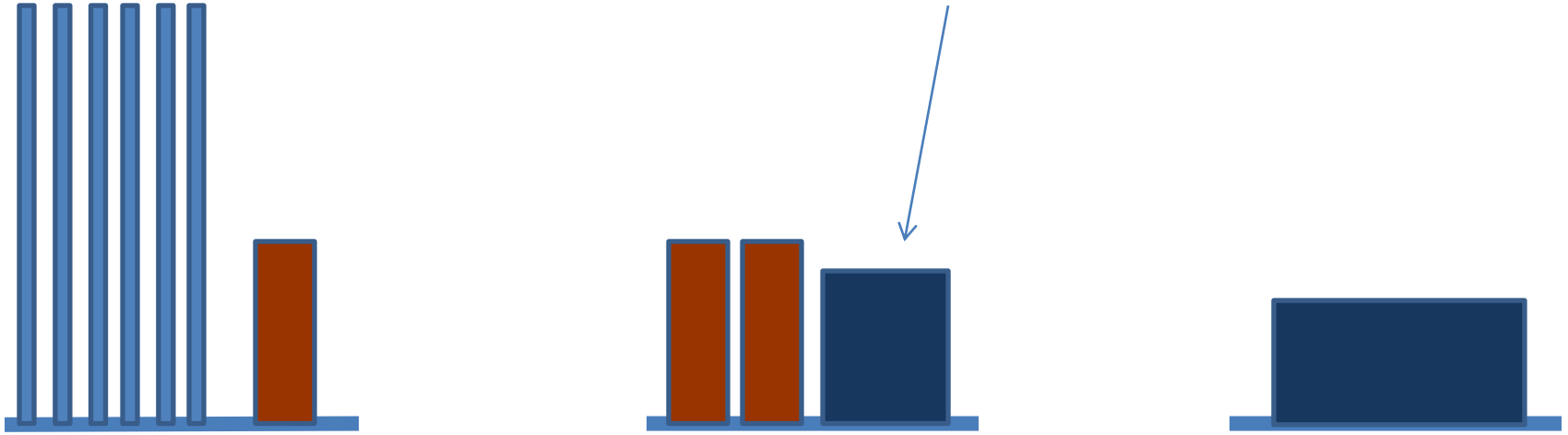
Spectrum Migration

Add a 10 MHz LTE channel at 2100?



900 MHz

2100 MHz

2600 MHz

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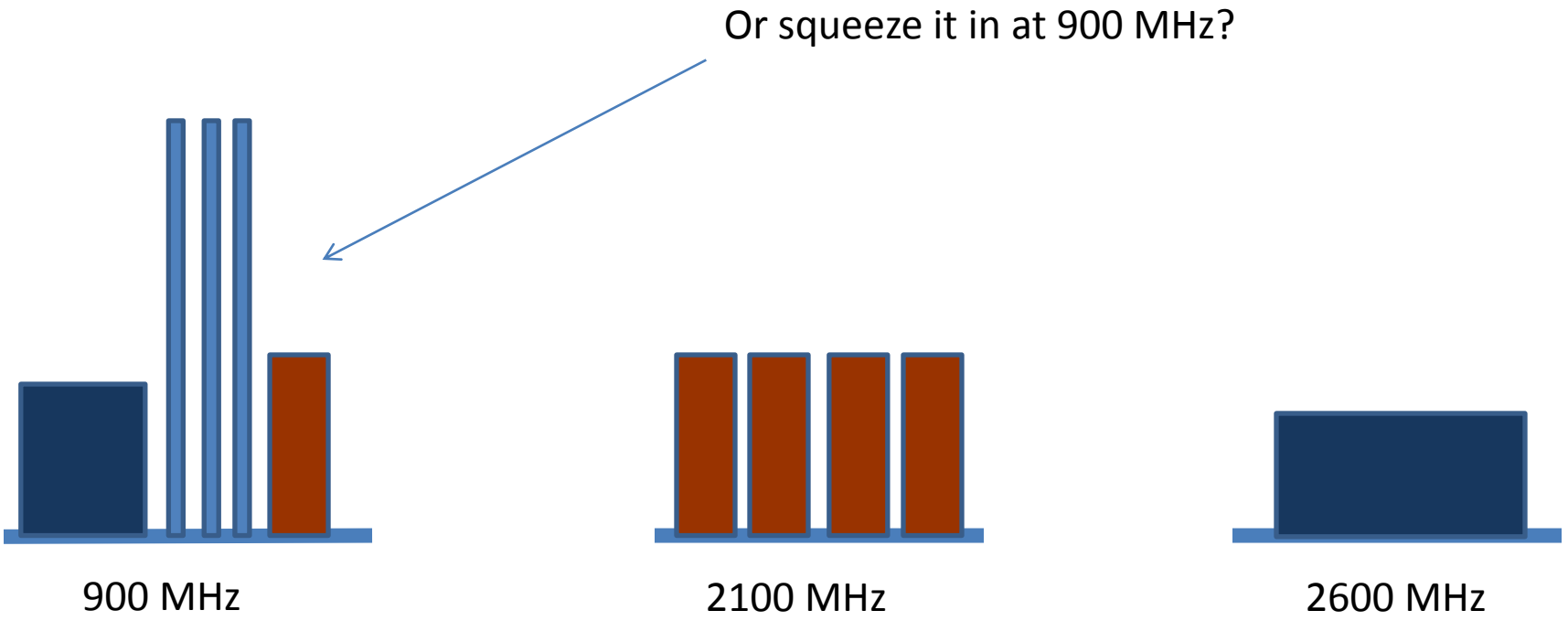
Spectrum Migration



Spectrum options are going to get messy!

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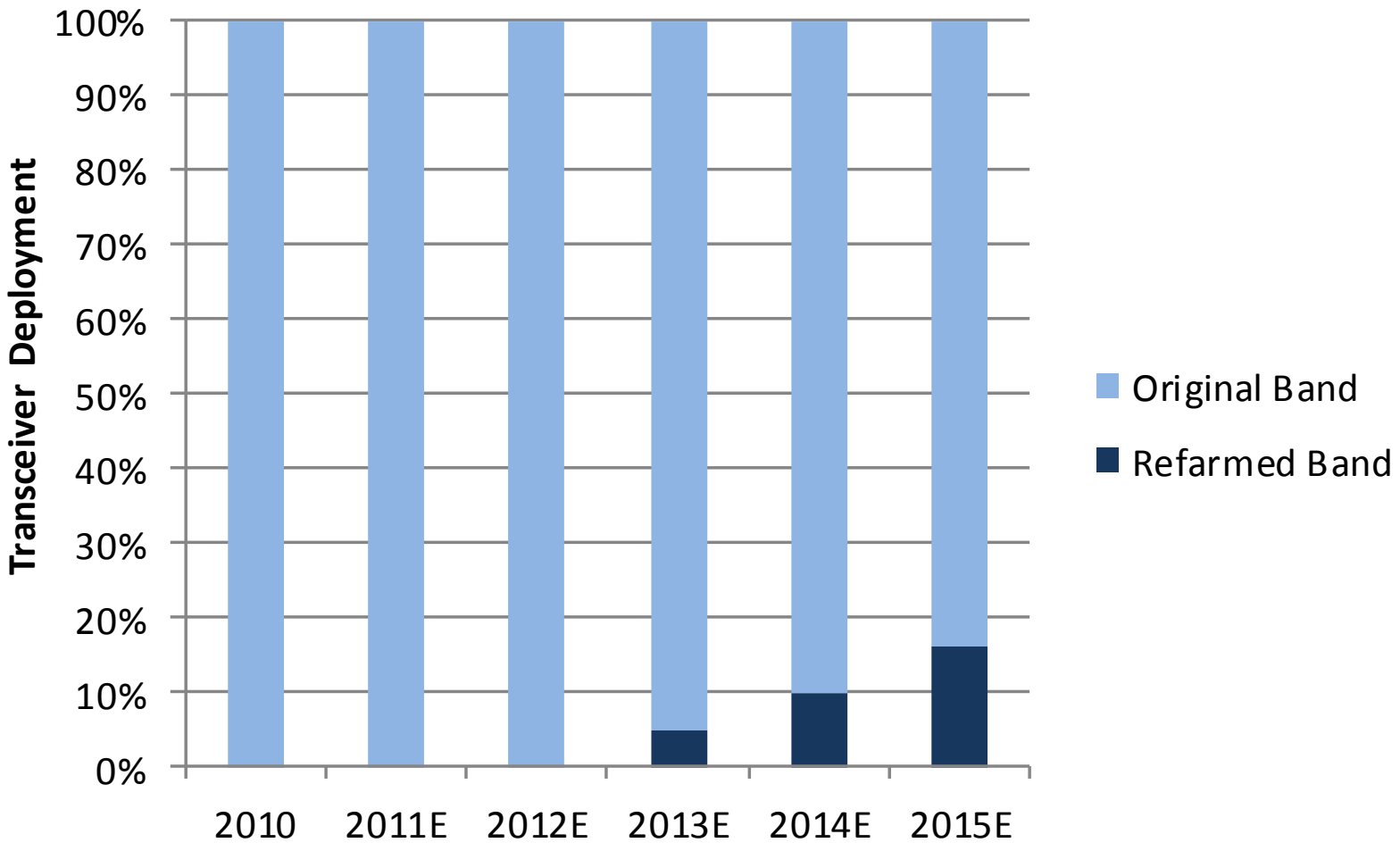
LTE will be deployed in 2G/3G bands



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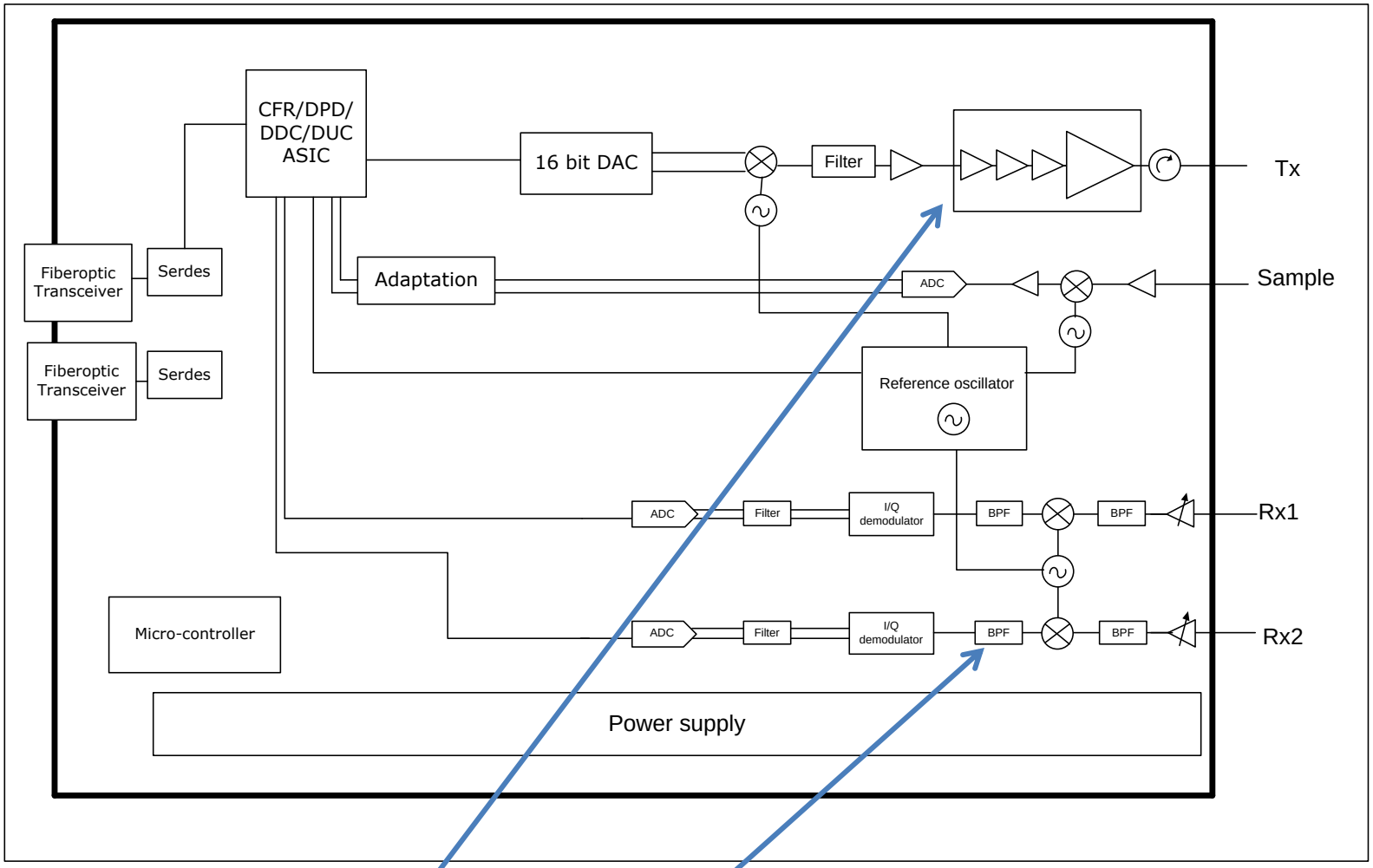
Technology Impact

Remote Radio Head Architecture



Wider bandwidth in the PA and Receiver front end!

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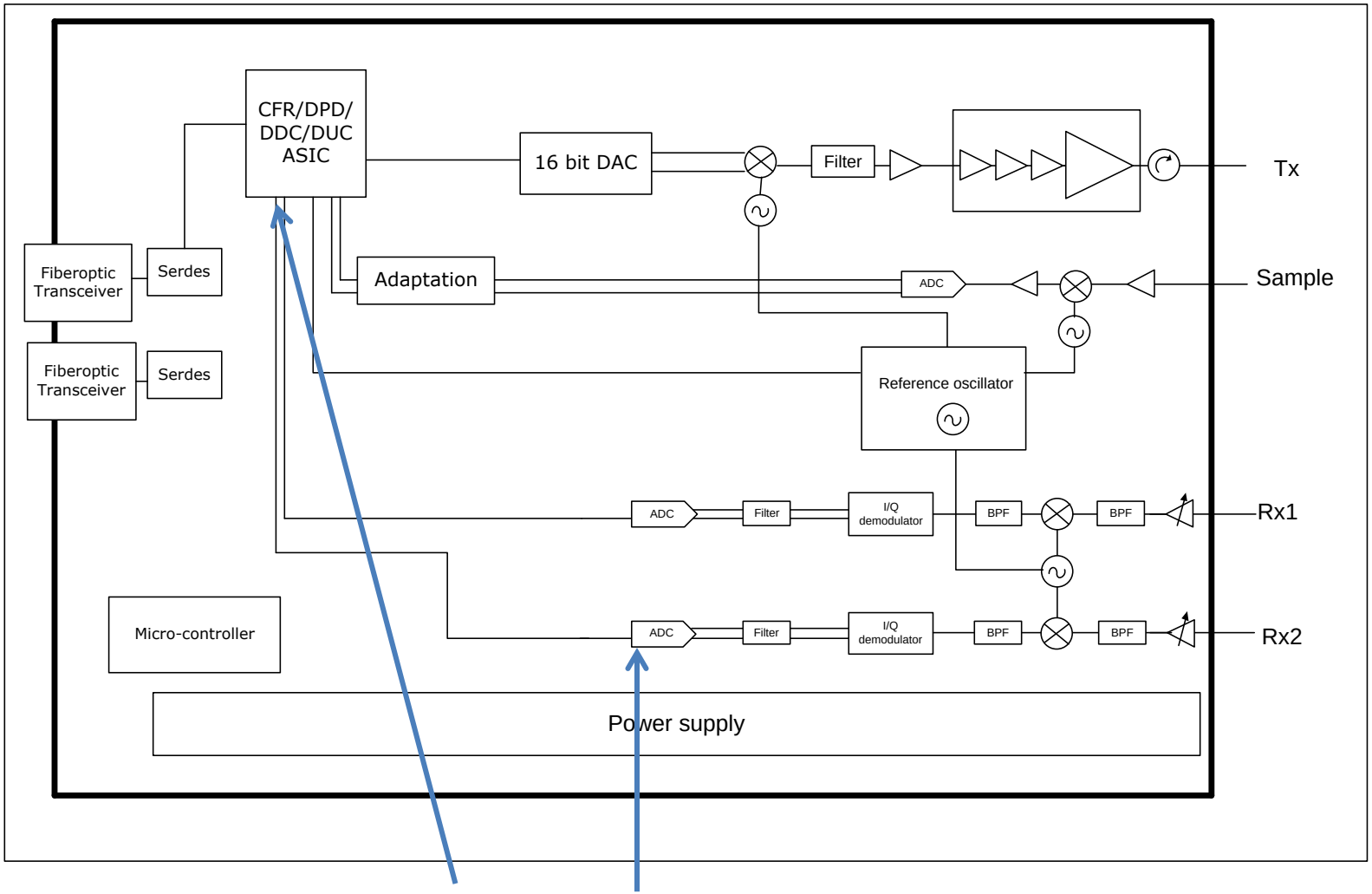
Remote Radio Head Architecture



Flexibility built into the DUC/DDC and data converters

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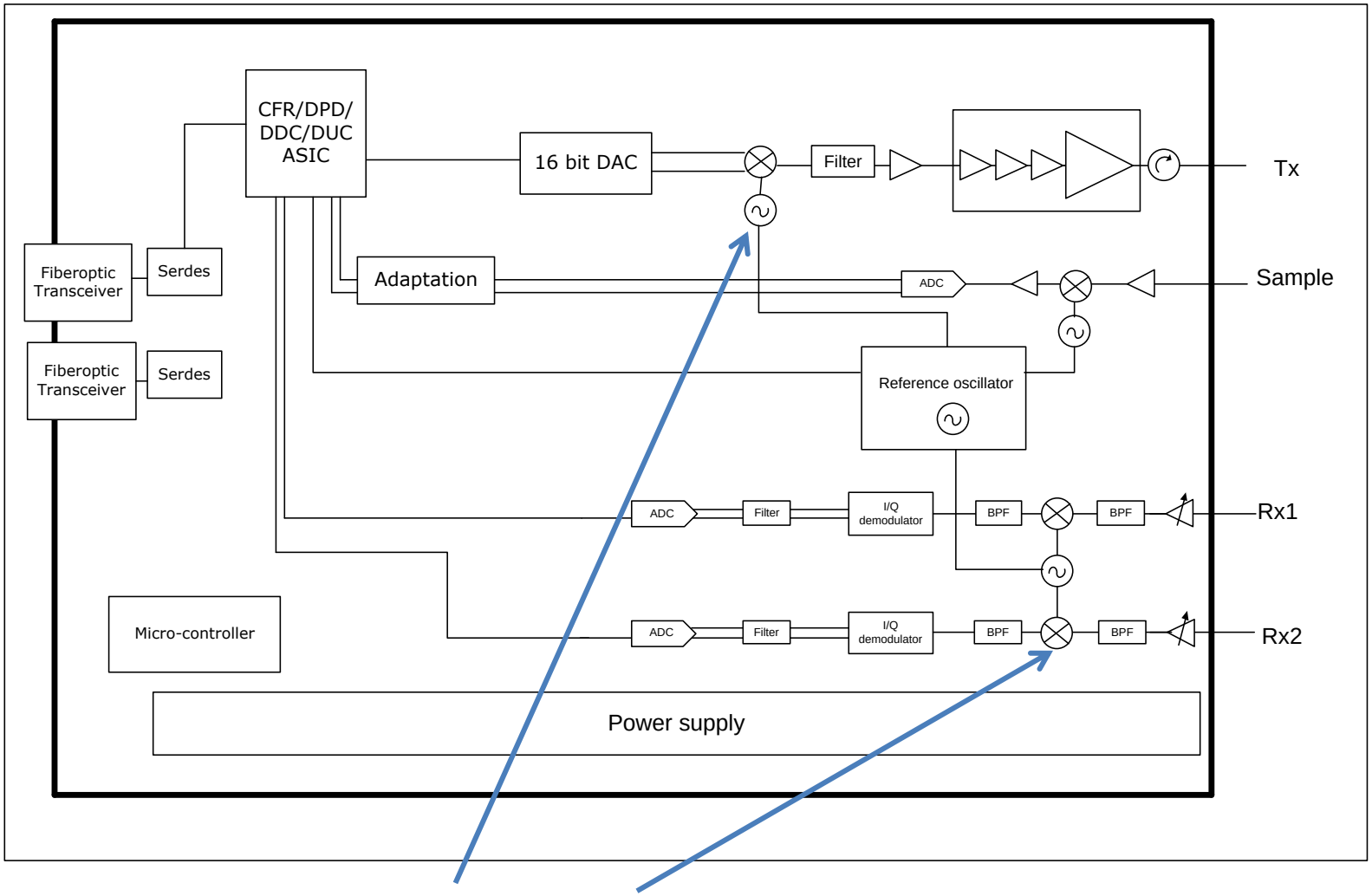
Remote Radio Head Architecture



Higher phase noise performance in LOs and modulators

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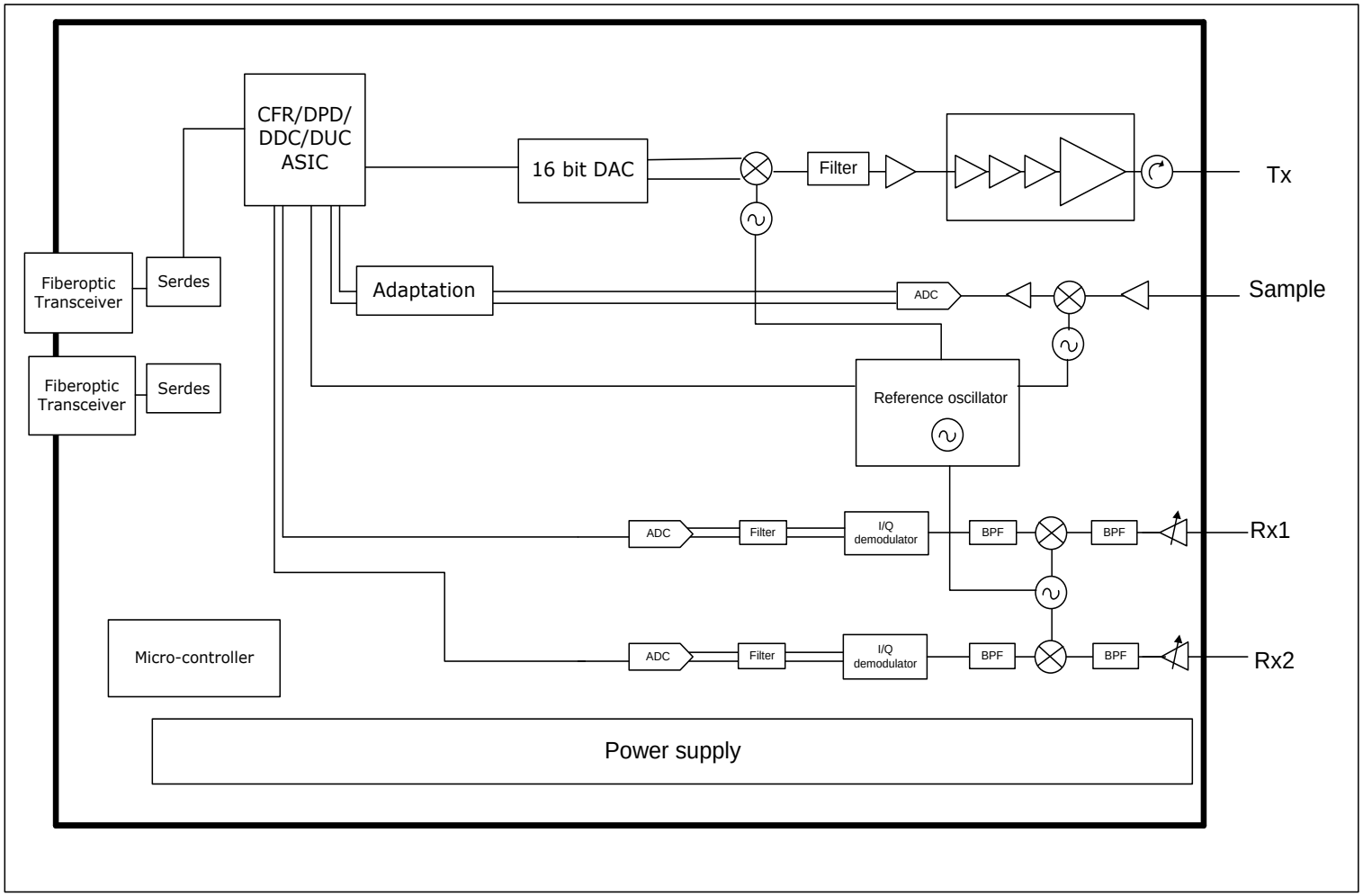
Remote Radio Head Architecture



The opportunity lies in multimode at a single mode cost!

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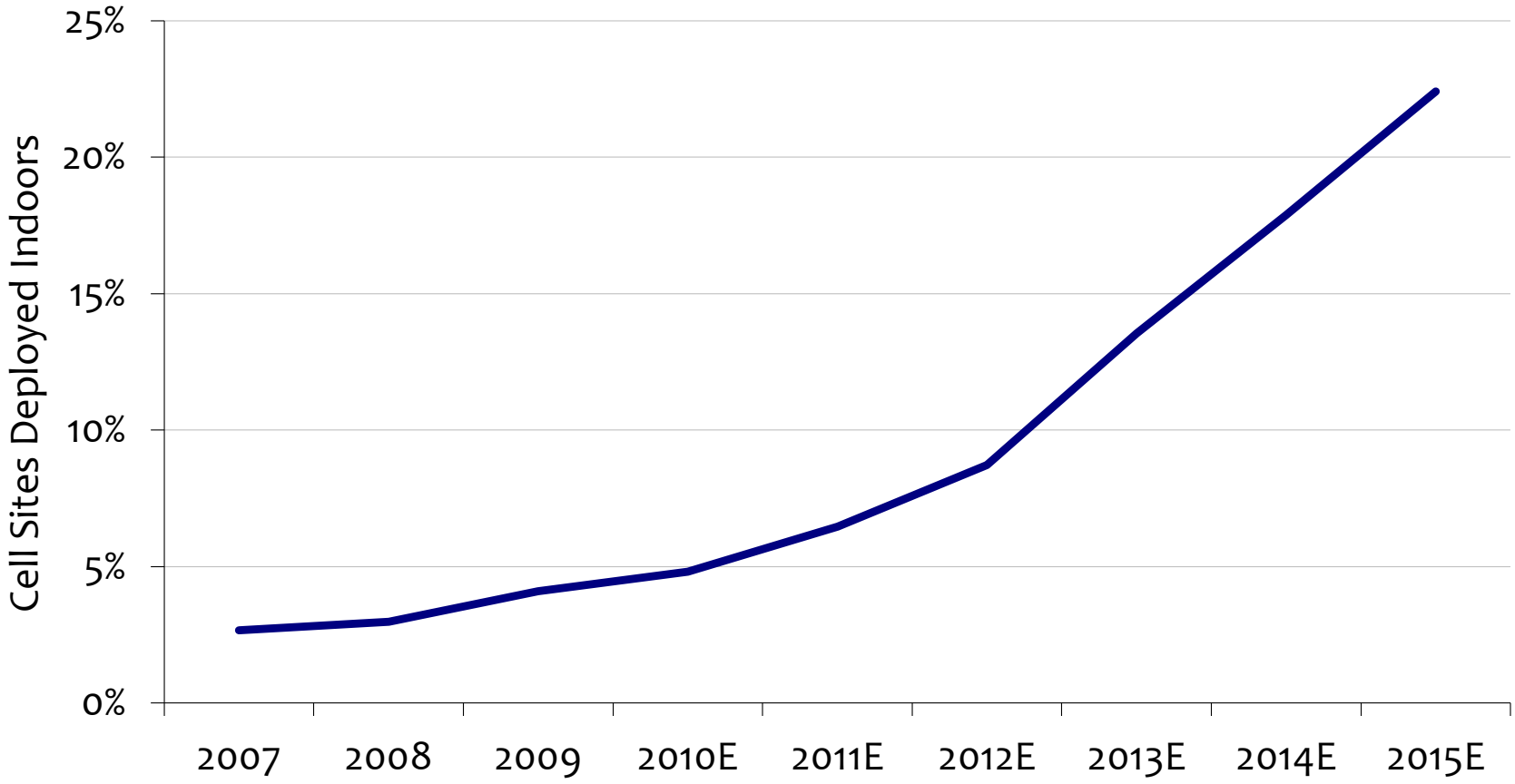
Where is the opportunity for SDR/CR?

Migration to Indoor Coverage



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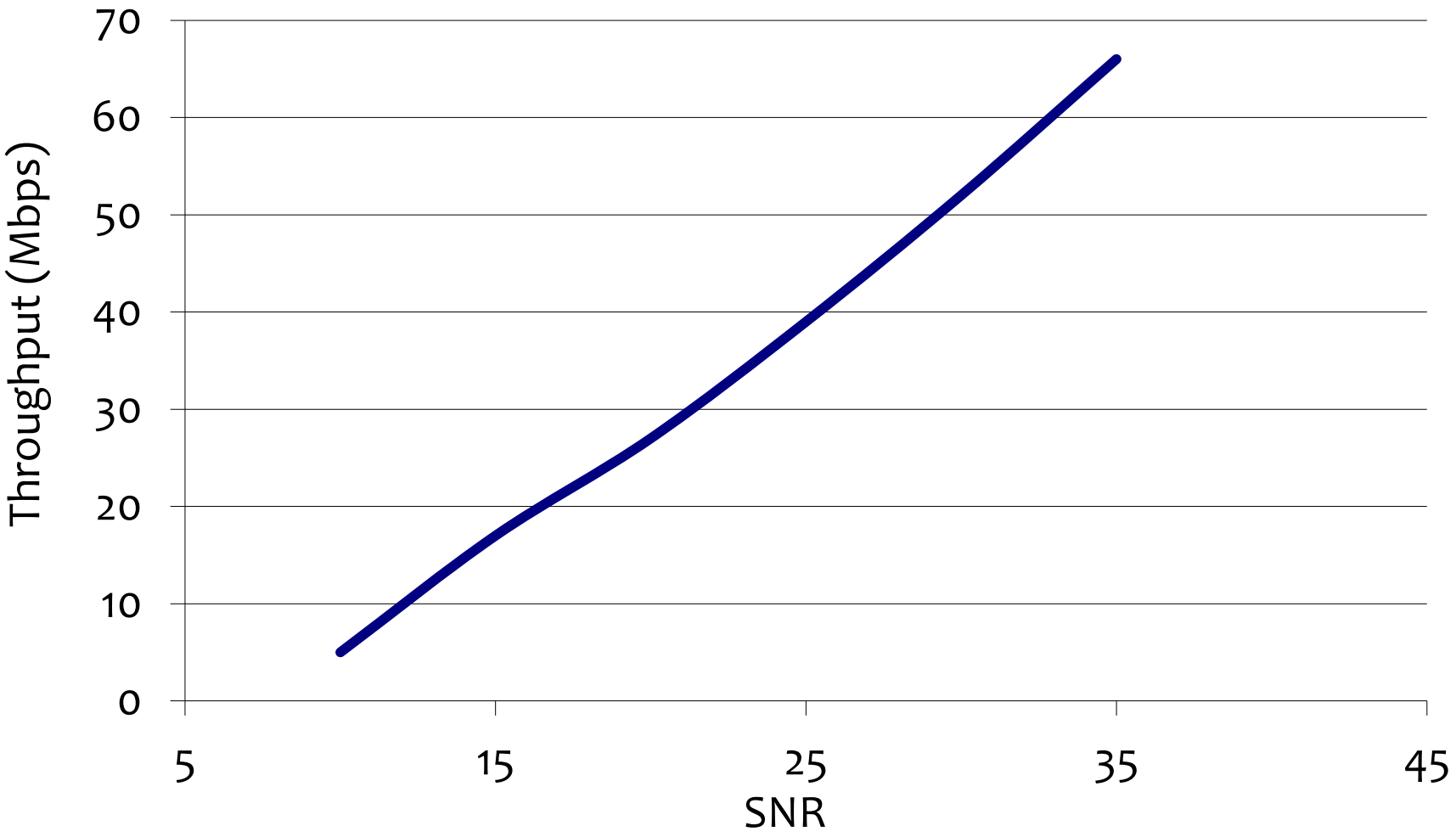
Why radios will move indoors



Source: NSN

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Impact of Indoor Coverage Options

Indoor Option	Pro	Con	Impact
Femtocells	Targeted coverage of data hogs	Pilot Pollution, 3-5 dB	Highly integrated and specialized
Enterprise Femtocells	Offloaded data	Network Complexity	Need highly integrated multi-mode radio (including Wi-Fi)
DAS networks	Dense capacity	Cost	Need multi-mode radio heads
Picocell	Tailored Capacity and Coverage	Resource Intensive	Need to move to multi-mode radios to avoid multiple installations
Repeaters/Relays	Spot coverage	No help to capacity	Limited

Opportunities for SDR/CR vendors

- *Macrocells:* Enable multi-mode operation and wide bandwidth without the cost impact
- *Enterprise Femtocells:* We need more modes, less degradation on the macro layer
- *DAS:* Radio heads needed to handle wide bandwidths and 2G/3G/4G modes
- *Handsets:* Front end complexity is choking handset vendors—need multimode front ends with better linearity/efficiency
- *Networks:* Enable SON use cases to move up, from autonomous self-initialization to true self-optimization

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