The Role of Small Cells in meeting the 1000x Challenge

rakon

WSTS 2015 Mary Carbin
mary.carbin@rakon.com

Content

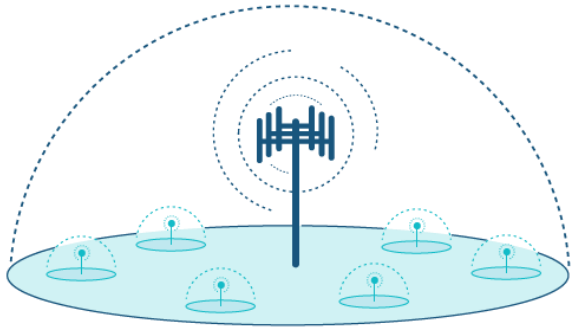
- How Small Cells support capacity increase for 1000x data traffic increase
- Role of Small Cell Forum
- Small Cell Cost Model & Oscillator Requirement
- Time holdover challenges
- Small Cell deployment volumes & forecast
- Summary

The 1000x data traffic challenge

rakon

- Cisco's VNI 2014 predicts mobile data traffic will increase nearly 11-fold between 2013 & 2018
- Networks need more capacity via
  - Greater efficiency
  - More spectrum
  - More Small Cells
- Challenge needs to be met in a cost effective way
- Small Cells are the most significant technological innovation to create hyper dense Heterogeneous Networks
- Support innovative deployment models

How do small cells support that?



- Small Cells are scalable, low cost and low power
- Incorporate interference management techniques
- Self-organizing networks (SON) bringing Plug & Play with minimal RF planning
- Capacity closer to the user providing scalability
- Innovative deployment methods
  - Multi-radio technology (3G, 4G, Wi-Fi)
  - Indoor/outdoor locations, residences, enterprises, public sites
  - Deployments by MNOs and end users alike

What is the Small Cell Forum's role?

rakon

- What? The Small Cell Forum's mission: "Accelerating small cell adoption to change the shape of mobile networks and maximize the potential of mobile services".

- Why? Small cells are needed to provide broader, denser mobile coverage for everyone everywhere. We provide operators a "how to guide" for small cell deployments, including the business case, deployment guidelines, reference architectures, case studies, backhaul recommendations, network architecture and more!

- How? Our work is focused around "Releases" or sets of documents detailing small cell deployment use cases. We identify the drivers and break down the barriers to small cell deployment.

SMALL CELL FORUM
HOME | ENTERPRISE | URBAN | RURAL

Small Cell Forum Release Program

rakon

Release One: Residential

Release Two: Enterprise

Release Three: Urban

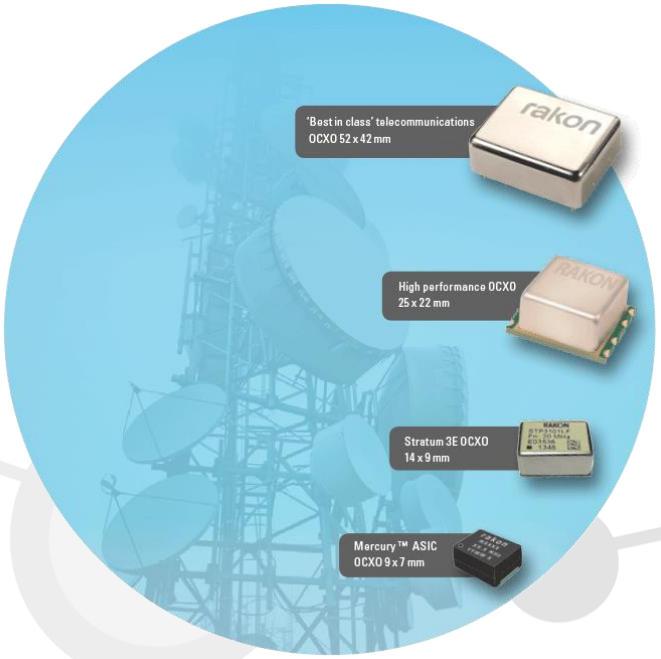
Release Four: Urban

Available for all to download at www.scf.io

SMALL CELL FORUM
HOME | ENTERPRISE | URBAN | RURAL

Cost Model and Oscillator Requirement

- Cost Model for Small Cells is very low (<1/10) compared to a Macro Cell base station
- The Oscillator is a key component to enable the Small Cell to meet:-
  - 3GPP synchronisation specifications for Air Interface
  - ITU network standards
  - 3G/4G EVM masks
- Oscillator choice depends on synchronisation techniques
- Oscillator performance needs to be guaranteed for the life of equipment



Small Cell Synchronisation Options

rakon

- Synchronisation techniques:
  - Network based
    - Precision Time Protocol (PTP)
    - Network Time Protocol (NTP)
    - Synchronous Ethernet (SyncE)
  - Non network based
    - Global Navigation Satellite Systems (GNSS, e.g. GPS)
    - Cellular Network Listening (CNL)

Synchronisation solution depends on several factors

- Class of Small Cell
- Frequency or Phase/Time synchronisation
- Indoor / Outdoor Small Cell

- In practice hybrid solutions are used

3GPP Synchronisation Requirements

rakon

Radio Technology	Base Station Description	Frequency Accuracy (FDD & TDD)	Phase Error (TDD)	CoMP & eICIC (FDD & TDD
LTE	Wide area, >3k radius	50ppb	±5µs	±0.5 to ±5µs
	Wide area, ≤3k radius	50ppb	±1.5µs	±0.5 to ±5µs
	Local area	100ppb	±1.5µs	±0.5 to ±5µs
	Home BS >500m radius	250ppb + T_{prop}µs[1]	±1.33µs	±0.5 to ±5µs
	Home BS ≤500m radius	250ppb	±1.5µs	±0.5 to ±5µs

- Note Frequency Accuracy is for air interface
- Oscillator accuracy requirements significantly less

Time holdover challenge

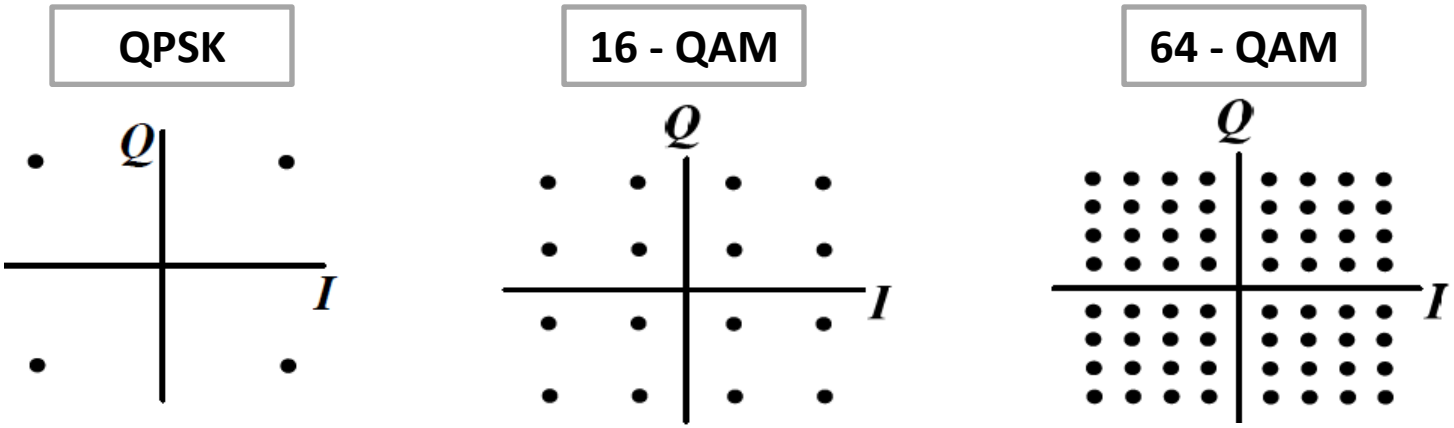
- Oscillator selection and performance is key for Small Cell deployments that require phase/frequency holdover
- Small phase error and longer holdover periods need better oscillators – but $$$!
- From the oscillator perspective the biggest effects on it's holdover performance are:
  - Temperature change (°C)
  - Temperature change rate (°C/min)
  - Overall oscillator stability (±ppb over temperature range)
  - Frequency Slope of the oscillator (ppb/°C)
- Applying a realistic practical thermal profile allows optimized oscillator performance v price options
- Holdover calculation tool (xls) available

EVM Requirements for LTE

- **To support higher bandwidths QAM rates are increasing:**
  - HSPA Up to 64 QAM
  - LTE Up to 64 to 128 QAM depending on signal quality
  - LTE-A Up to 128 QAM (in some cases 256 QAM)
- **Higher QAM rates rely on tighter EVM limits**
  - Error Vector Magnitude (EVM) is a measure of how well the incoming signal constellation points conform to their ideal locations. Higher QAM rates have more points, packed closer together.
  - The reference clock phase noise strongly influences the transmitter/receivers EVM performance.
- **Therefore reference clocks with low phase noise are crucial to support higher data rates**
  - Higher frequency reference clocks (>40 MHz) are an advantage as they reduce the system level phase noise by reducing the multiplication (20LogN rule) induced noise.
  - Poor reference clock phase noise means its impossible to distinguish one code from another and the system is forced to reduce the QAM rate and therefore the available bandwidth.

Error Vector Magnitude - Example

rakon



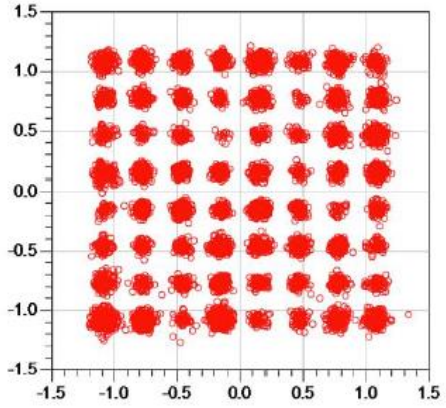
More and more bandwidth = faster download/upload

Poor Phase Noise

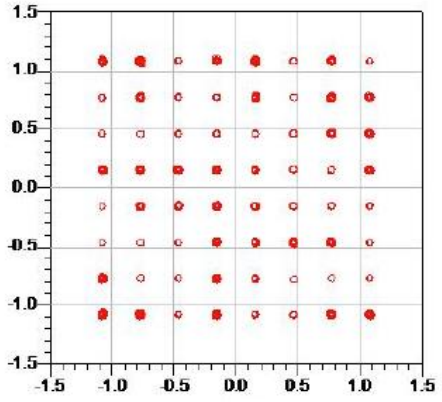
=

Harder to decode

EVM (dB)	EVM (°)
-28	2.28



EVM (dB)	EVM (°)
-40.2	0.56



Good Phase Noise

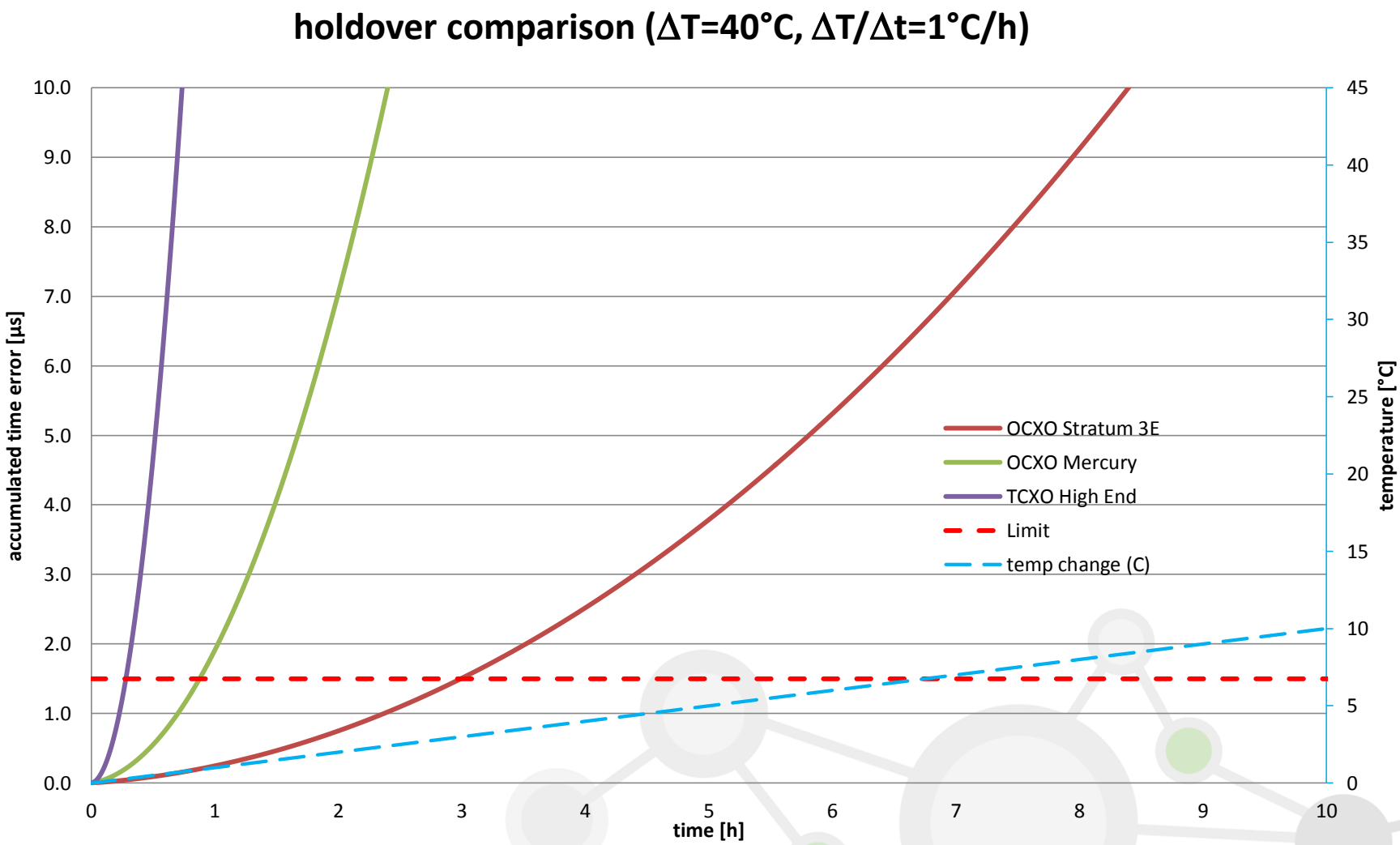
=

Easier to decode

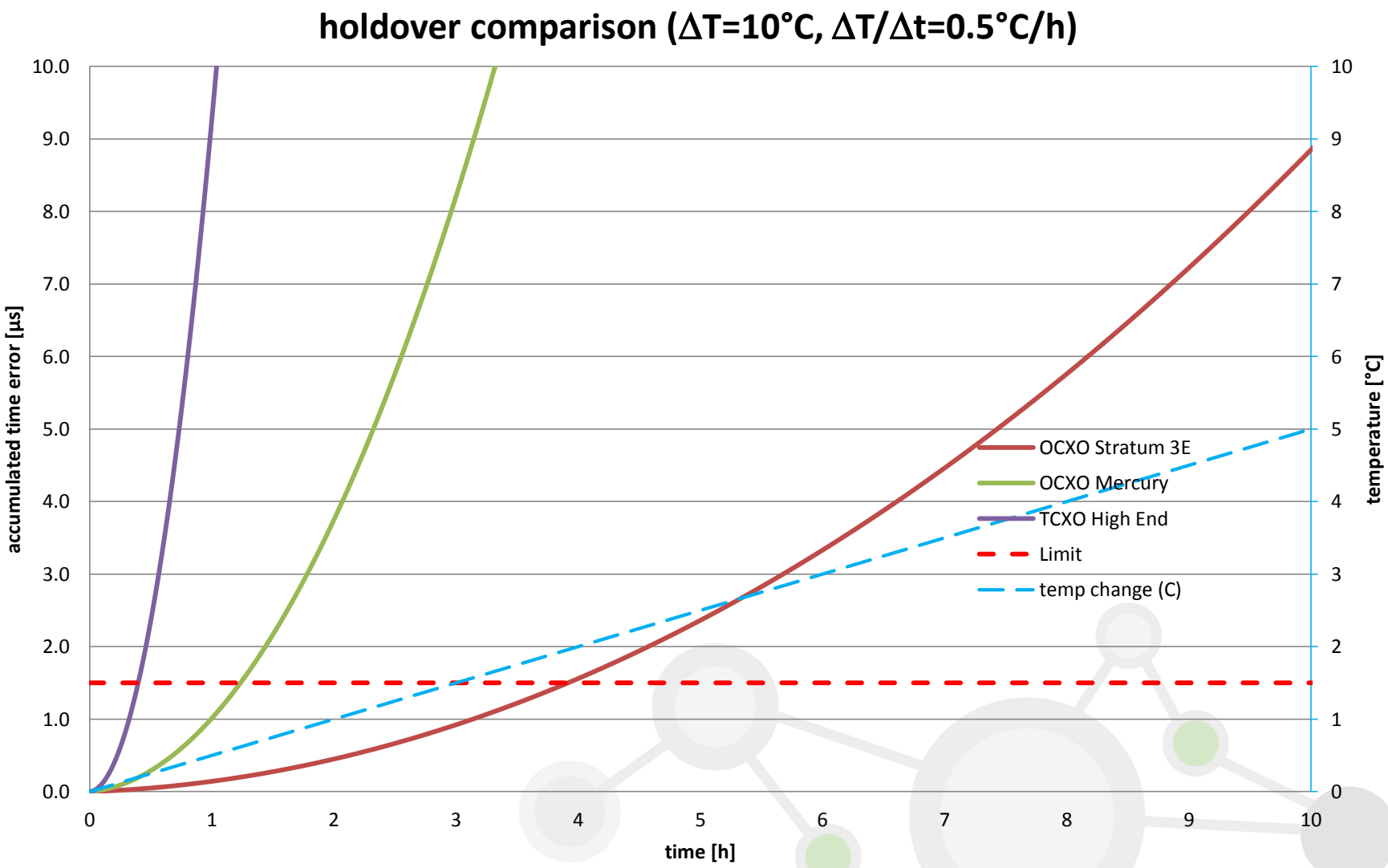
Cost Model and Oscillator Requirement

- Not all Small Cells are the same
  - Wide range of applications
- Oscillator is a key component
  - Range of performance capabilities & costs
  - Important not to over specify the oscillator
- One oscillator needs to serve both synchronisation and RF transceiver requirements
  - Different performance characteristics for both
- Oscillator power consumption important for PoE applications
- Need portfolio of oscillator products to optimize performance v cost

Oscillator performance v holdover

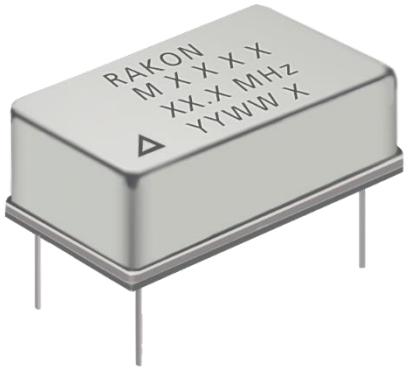


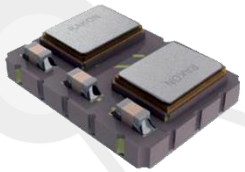
Oscillator performance v holdover



Oscillator innovation

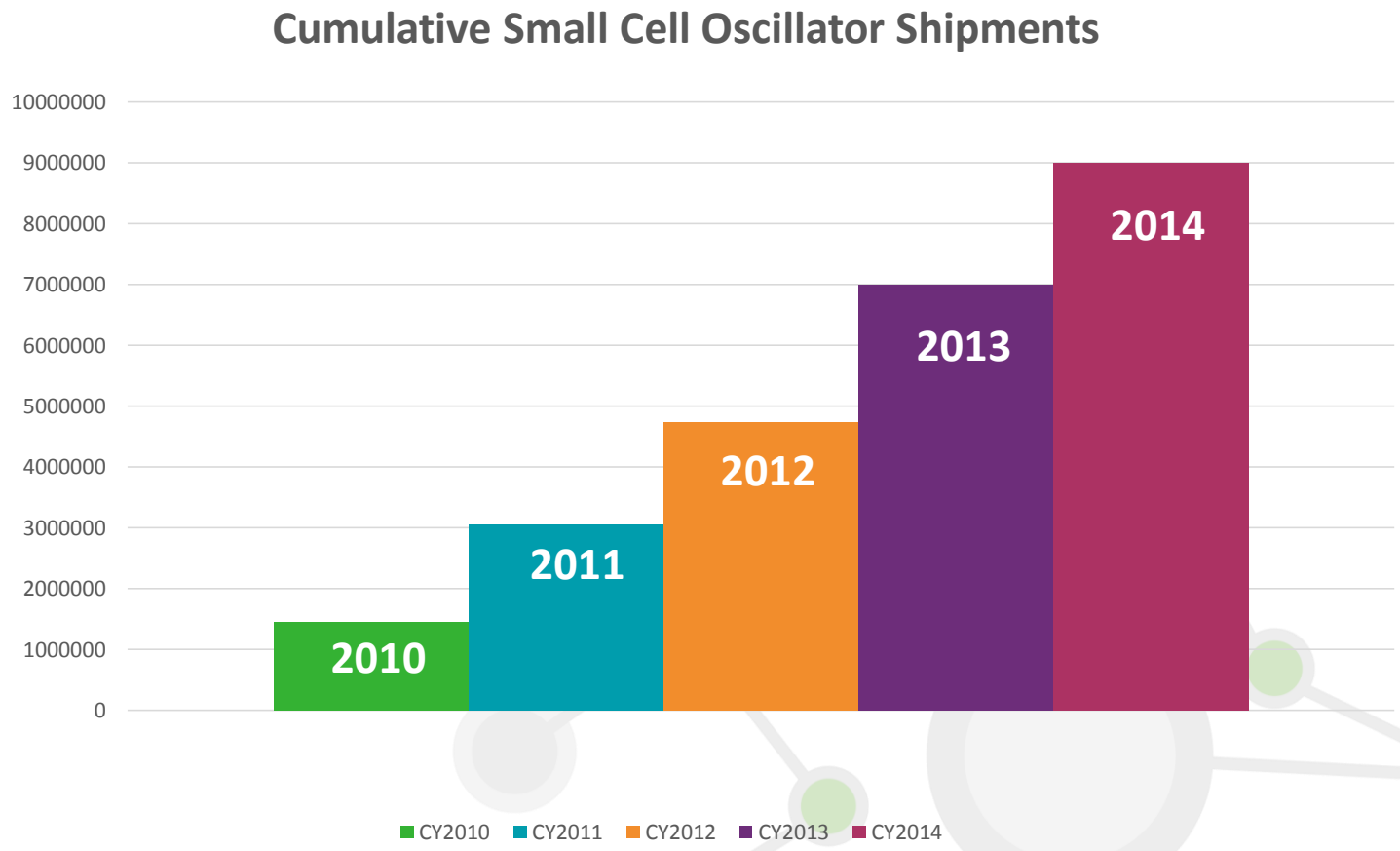
- Oscillator developers are being innovative with improving the performance of the oscillator by developing oscillators with:
  - Higher accuracies (<ppb over temperature)
  - Higher frequencies
  - Ageing compensation
  - Multi frequency outputs
  - Lower power consumption





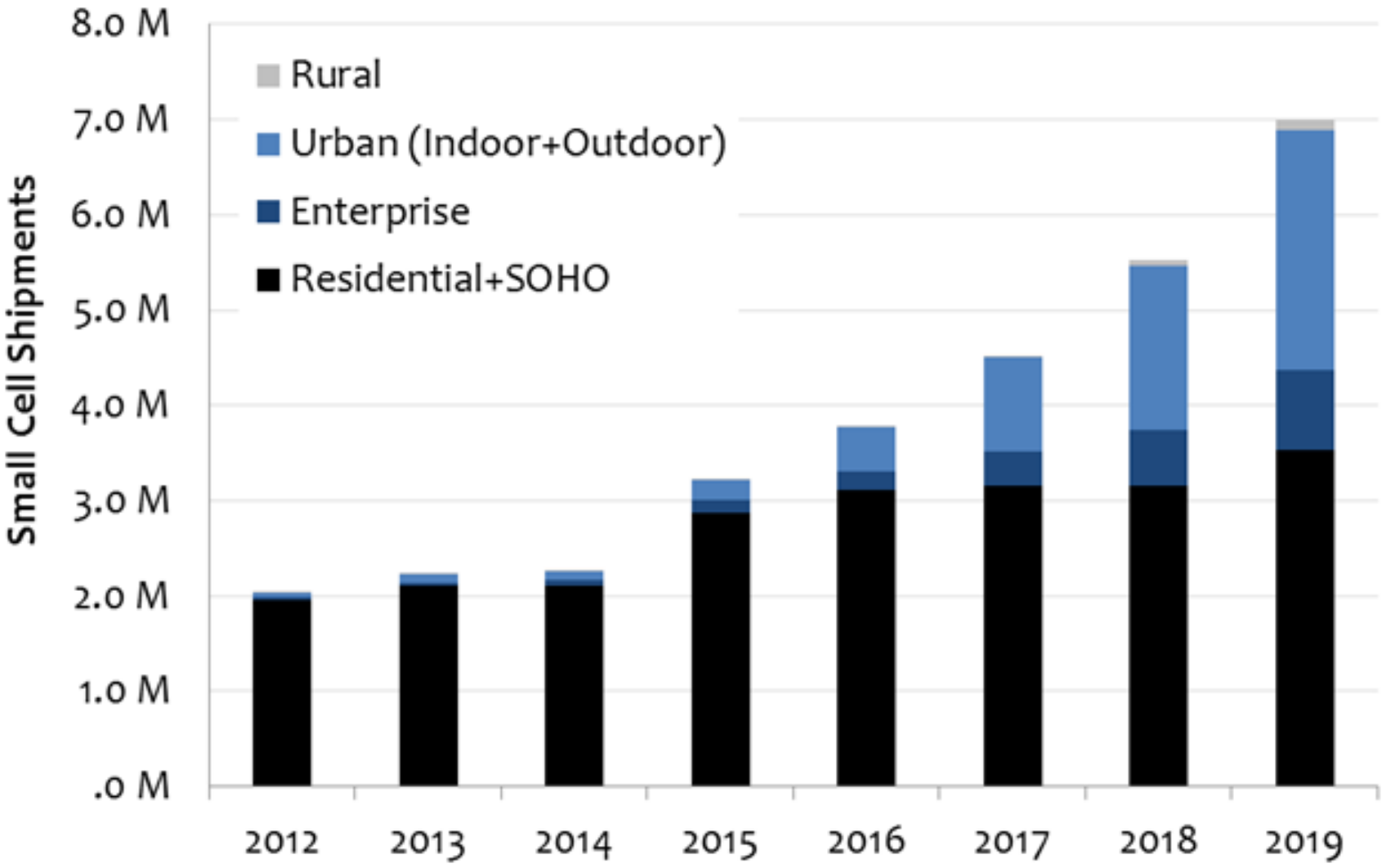
Small Cells Already Out There

- Cumulative volume of Rakon oscillator shipments for Small Cells to end of CY2014
- 10M units shipped to date



Small Cell Forecast

rakon



www.mobile-experts.net

Summary

rakon

- Small Cells are a key technology for rolling out HetNets to meet the increased capacity requirements to meet the 1000x data explosion
- Oscillators key component in meeting industry standards with cost effective solutions
- Be practical & realistic when specifying time holdover thermal profiles
- Oscillator innovation ongoing to deliver more performance for lower price/ less power/ smaller size
  - Talk to your supplier about your needs
- Around 10M Small Cells deployed now.
- Healthy forecast going forward – being realised AT LAST!
- For more information to join SCF contact scf.io

rakon

About Rakon

- Develop and produce innovative quartz oscillator products for several markets with focus on:

- HQ in Auckland, NZ with R&D in UK, NZ & France
- 7th member of Small Cell Forum in July 2007, now 150+ members

Awards

THE QUEEN'S AWARDS FOR ENTERPRISE: 2012
Rakon UK Ltd

femtoforum femtocell industry Awards 2011
winner
Judges' choice
Rakon
Ongoing enablement of femtocell market through provision of oscillators
rakon