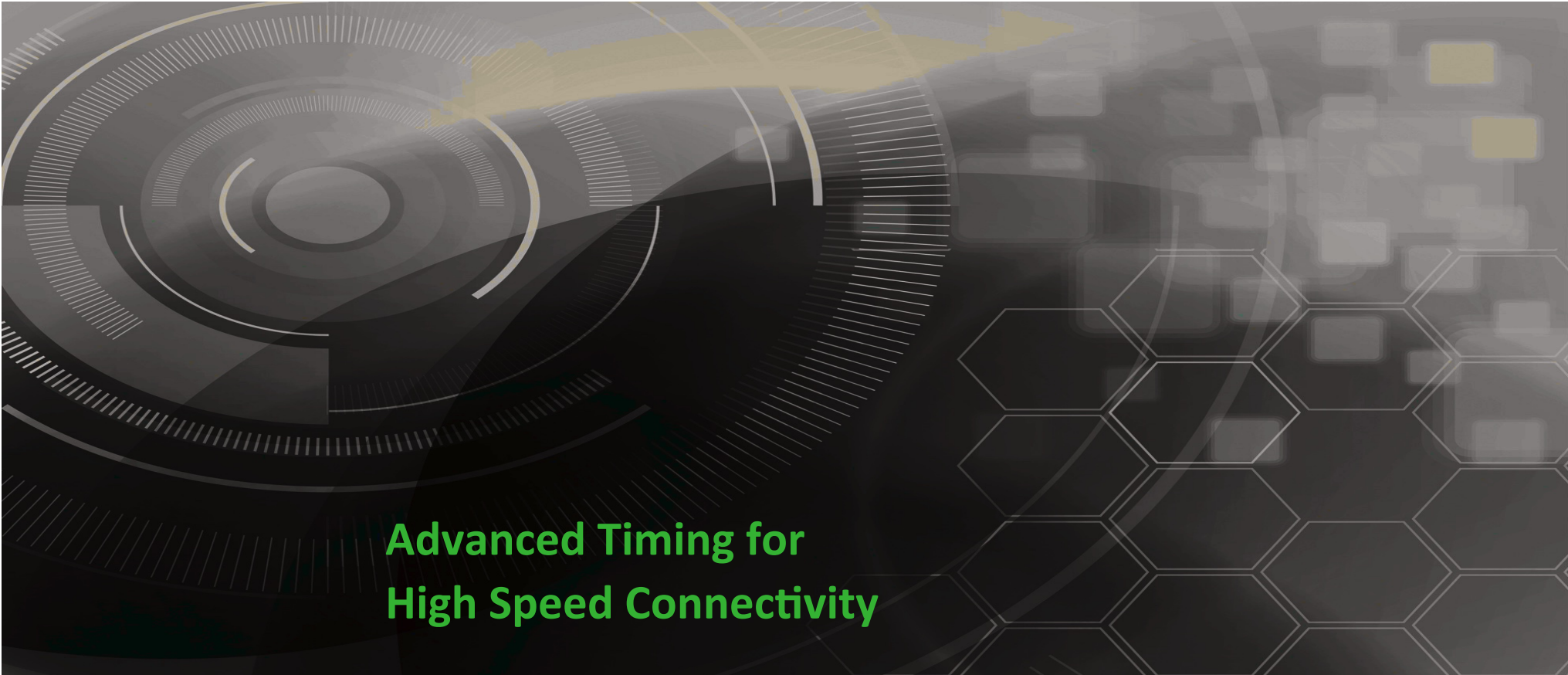


CONFIDENTIAL INFORMATION

Evolution of Synchronisation Implementations and Oscillator Requirements

rakon



**Advanced Timing for
High Speed Connectivity**

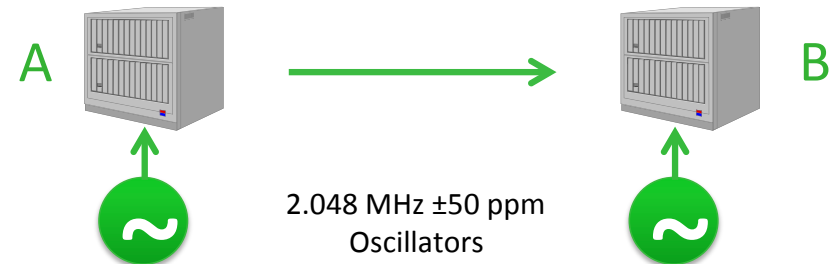
Topics

- ❑ Introduction
- ❑ Evolution of Networks & Synchronization
- ❑ Role of Oscillators
- ❑ Performance aspects
- ❑ Environmental effects
- ❑ Evolution of Oscillators
- ❑ Future trends

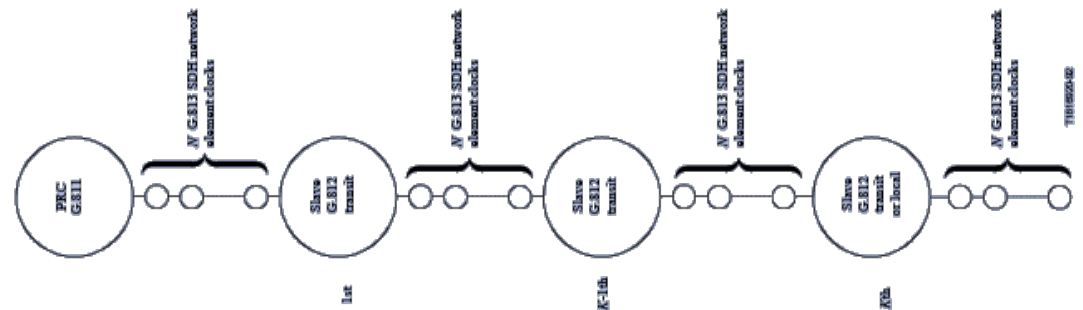
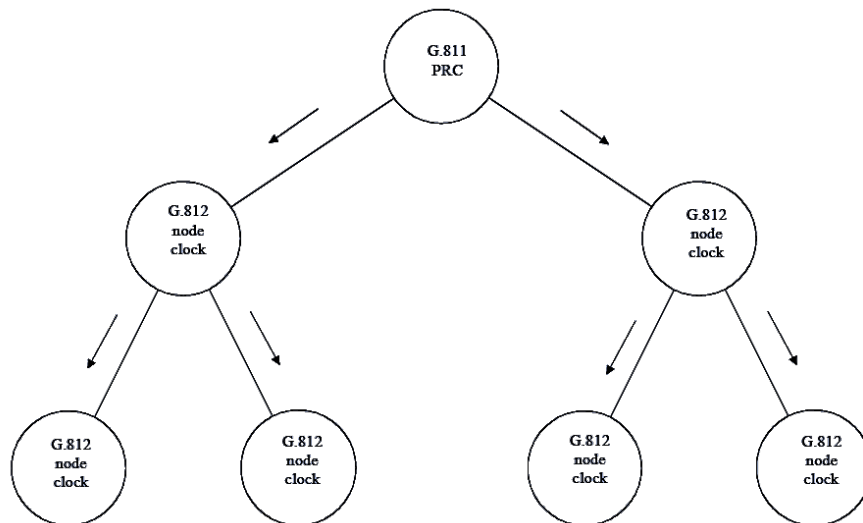
Introduction: Evolution of Networks

rakon

◀ Pleseochronous Digital Hierarchy



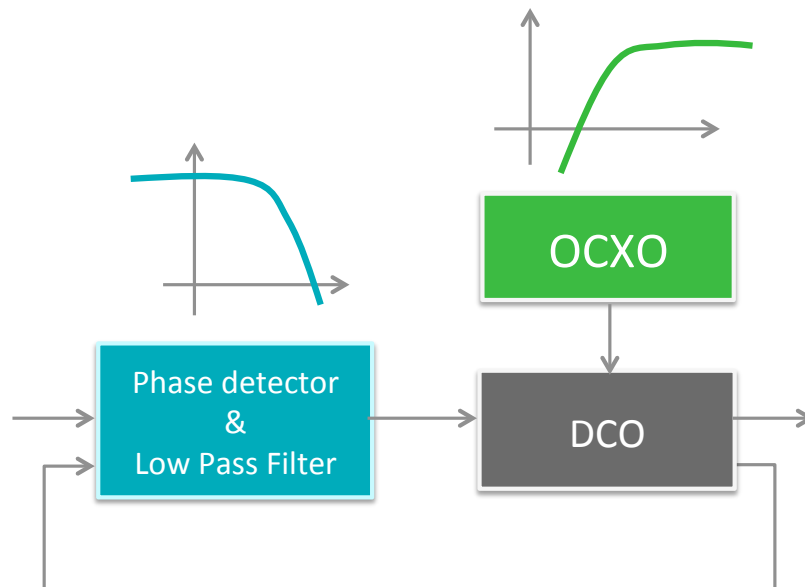
◀ Synchronous Digital Hierarchy



Role of Oscillators



- ◀ Oscillators present high pass effect to PLL output



- ◀ Fast variations appear at output, slow variations filtered by the loop
- ◀ Stratum 3 time constant is ~2 seconds
 - Reasonably stable oscillator has minimal effect

Oscillator impact on Performance Targets



< Free-run accuracy

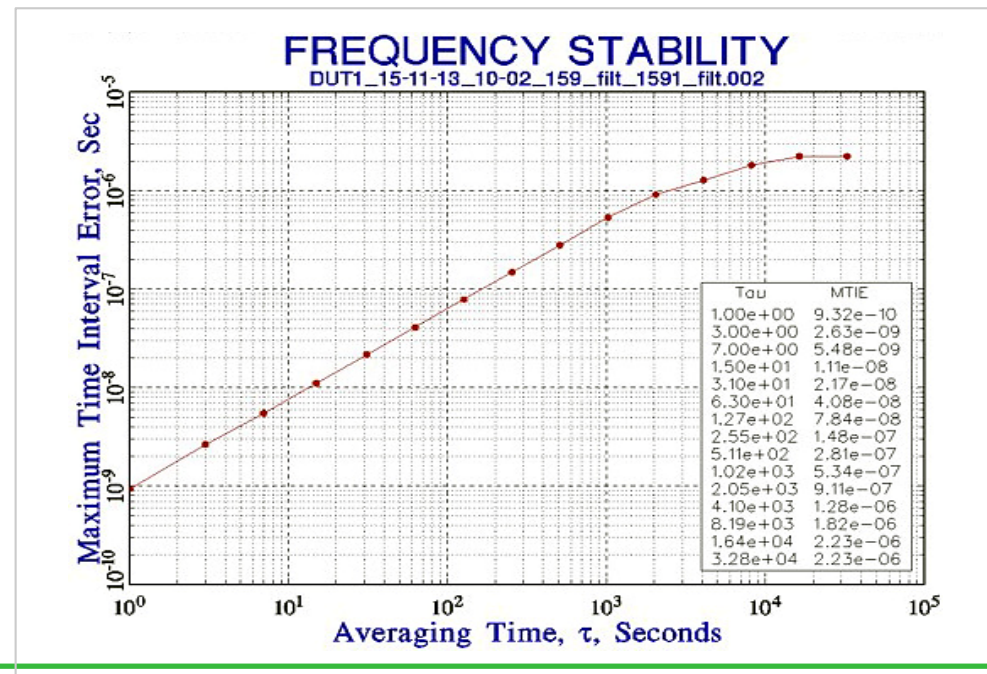
- And associated pull-in, Hold-in and Pull-out ranges

< Holdover performance

- As well as transients, input interruptions and phase discontinuities

< Wander Generation (at constant and variable temp)

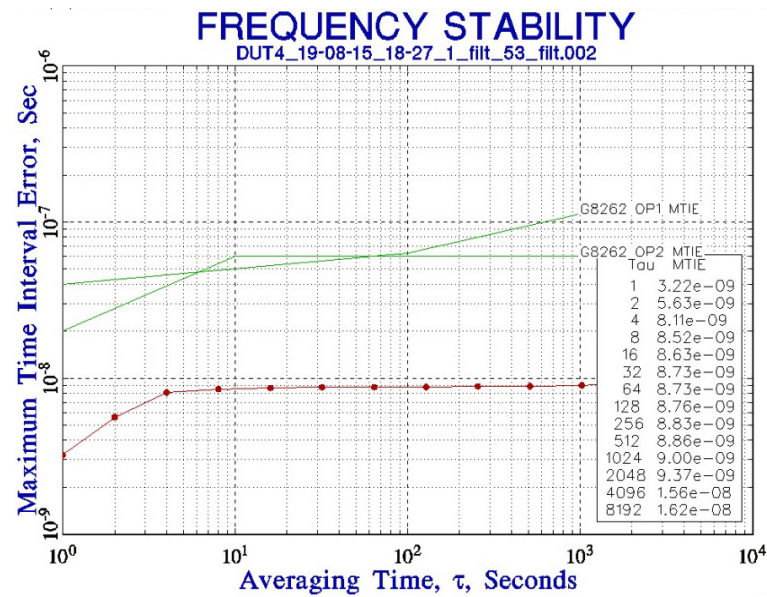
- At defined bandwidths, target MTIE and TDEV performances
- Impact of environmental conditions



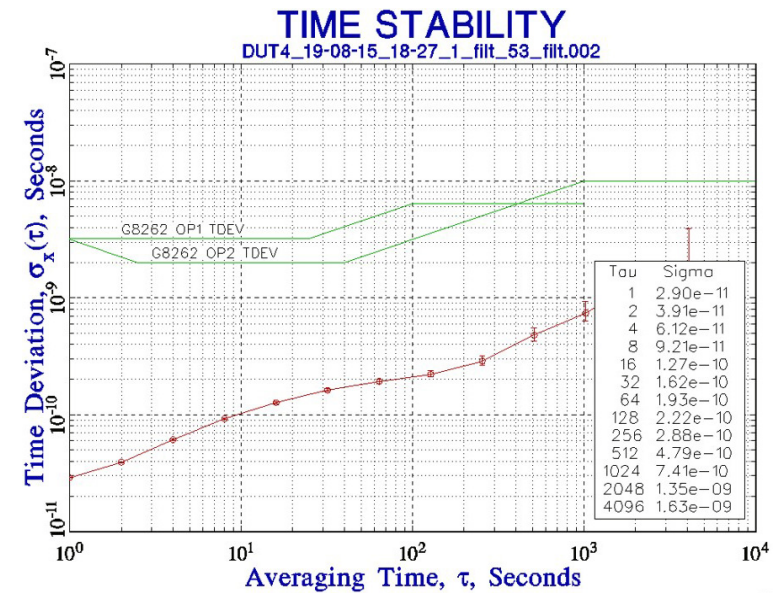
TCXO Performances at 0.1Hz Loop Filter



Frequency Stability



Time Stability



Packet Networks



- ◀ **The “PLL references” changes**
 - From clock edges to timestamps
- ◀ **Too many variables**
 - Number of nodes, packet rates, packet sizes, queuing techniques...
 - Stationary signals to Non-stationary
- ◀ **Use packet selection and low loop bandwidths**
 - Apply constraints on networks

- ◀ **Packet clocks have time constant of, say, 10s of minutes**
 - The oscillator has major impact – when temperature changes
 - A change of 0.5 °C/min is about 10s of °C!
- ◀ **F v T performance and Ageing directly impacts the packet based clocks**

Packet Synchronisation is Evolving!



◀ Various network configurations

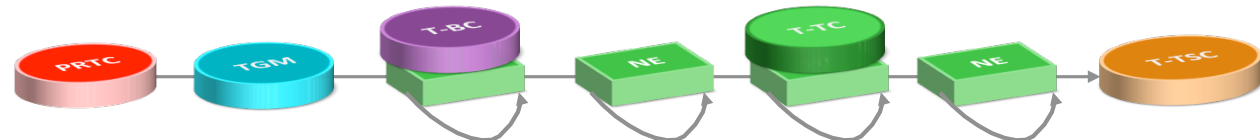
- ❑ **Unaware Network:**
NEs don't know about PTP



- ❑ **Partially Aware:**
Some NEs aware of PTP



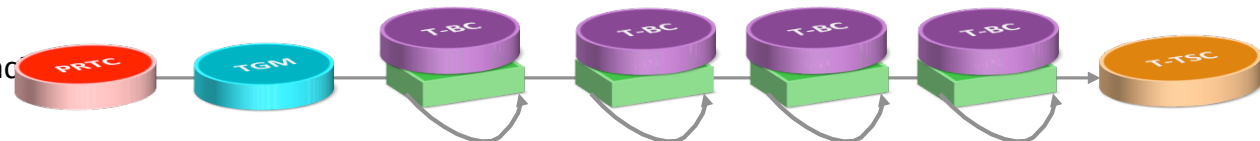
- ❑ **Partially Aware & SyncE:**
SyncE support from Physical Layer



- ❑ **Fully Aware; No SyncE:**
All NEs are aware of PTP



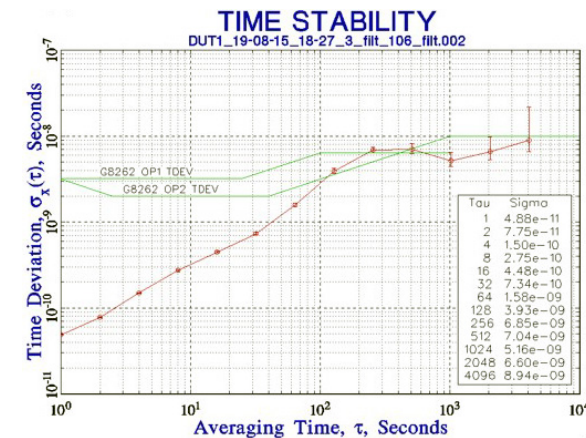
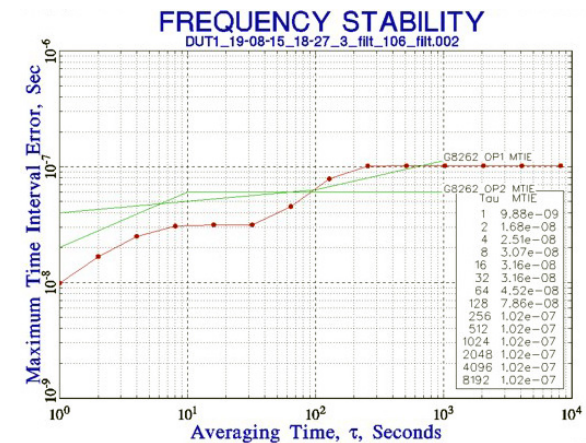
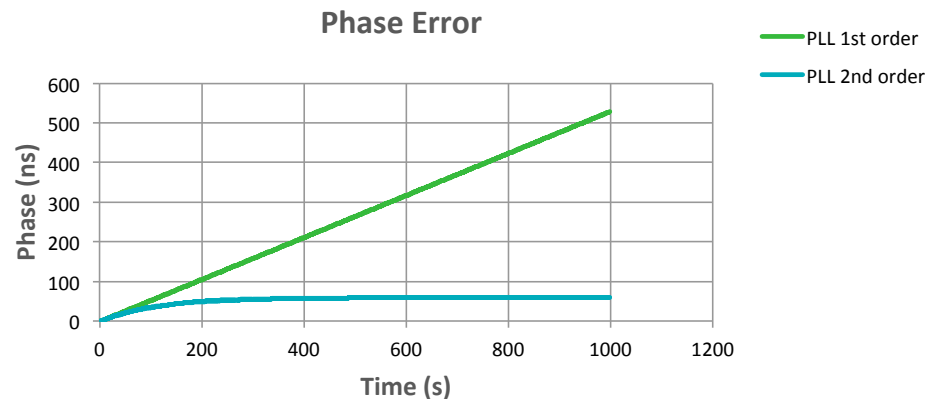
- ❑ **Fully Aware:**
All NEs are aware of PTP & SyncE



Effects of 0.05 Hz and 0.1 Hz Filters - OCXO

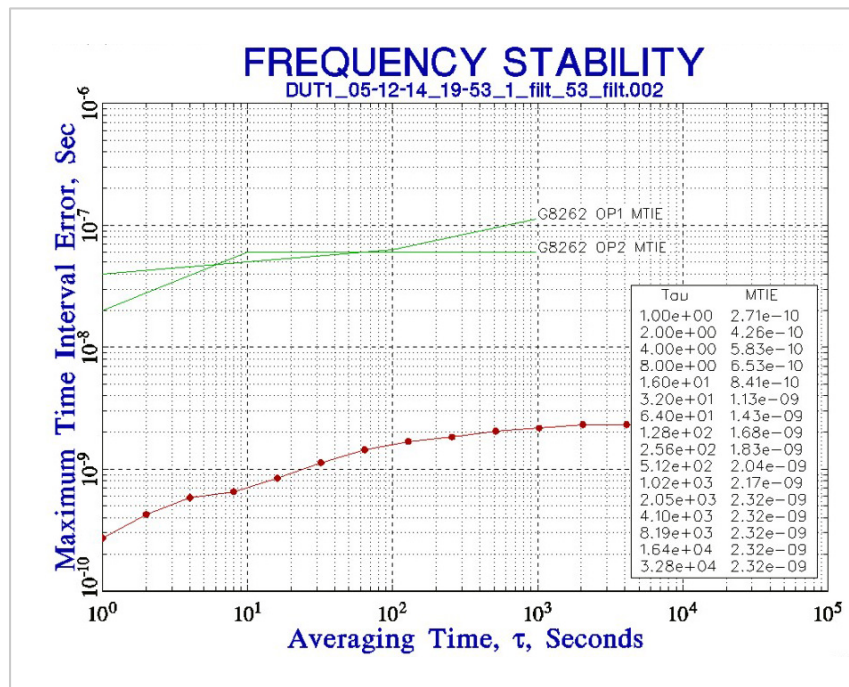


- ◀ T-BC suggests 0.05 Hz – 0.1 Hz bandwidth
- ◀ Practical situations may not have SyncE
- ◀ 40 ns MTIE requirement over temperature at 0.05 Hz:
 - The required temperature sensitivity is <3 ppb/°C
 - Assume: 2nd order PLL, 0.5 °C/min ramp
- ◀ An ovenised solution is required for such applications

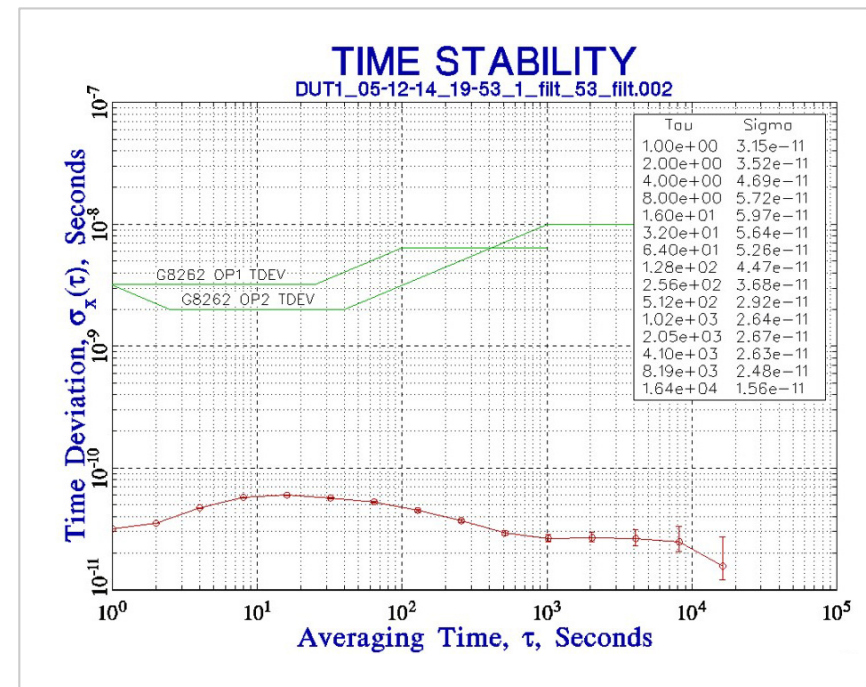


Performance at 0.05 Hz

Frequency Stability



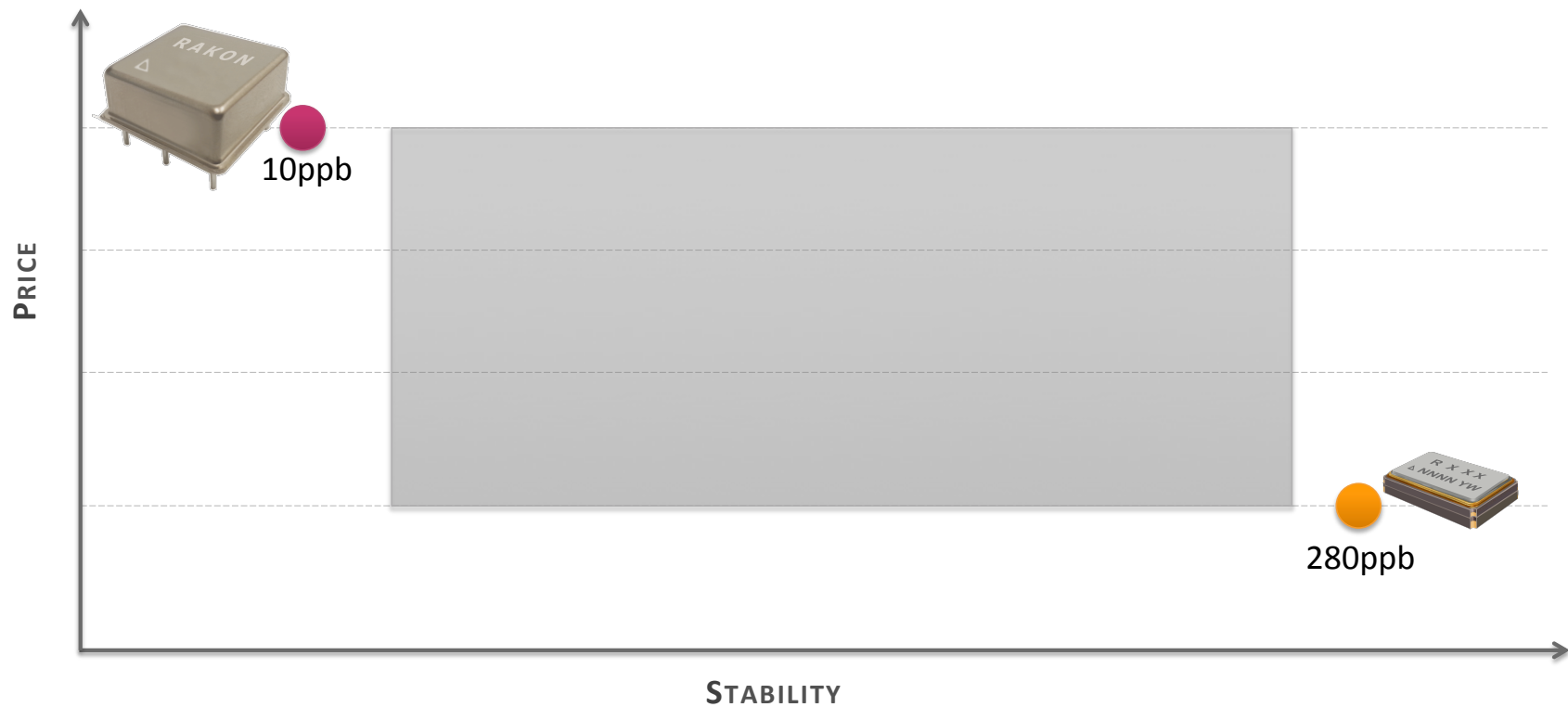
Time Stability



Traditional Oscillator Specifications

rakon

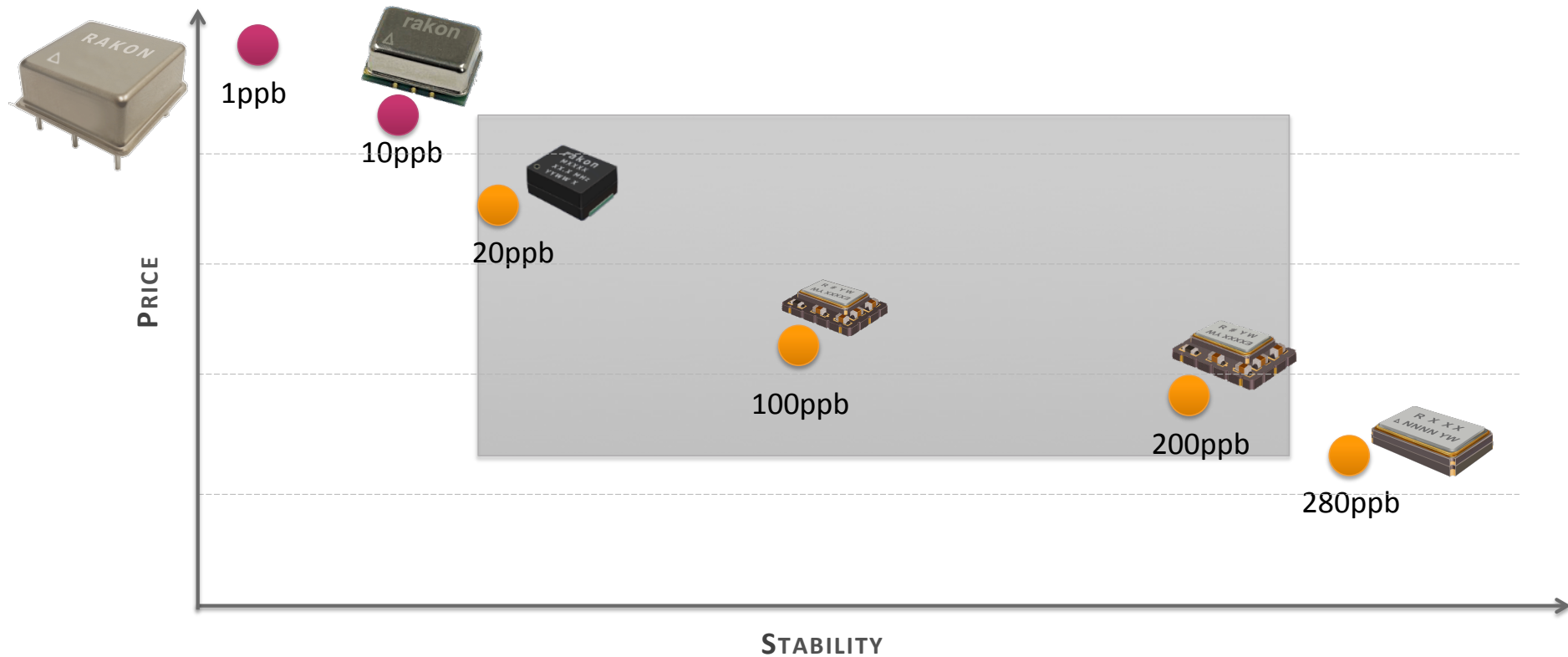
◀ Temperature Stability vs Price



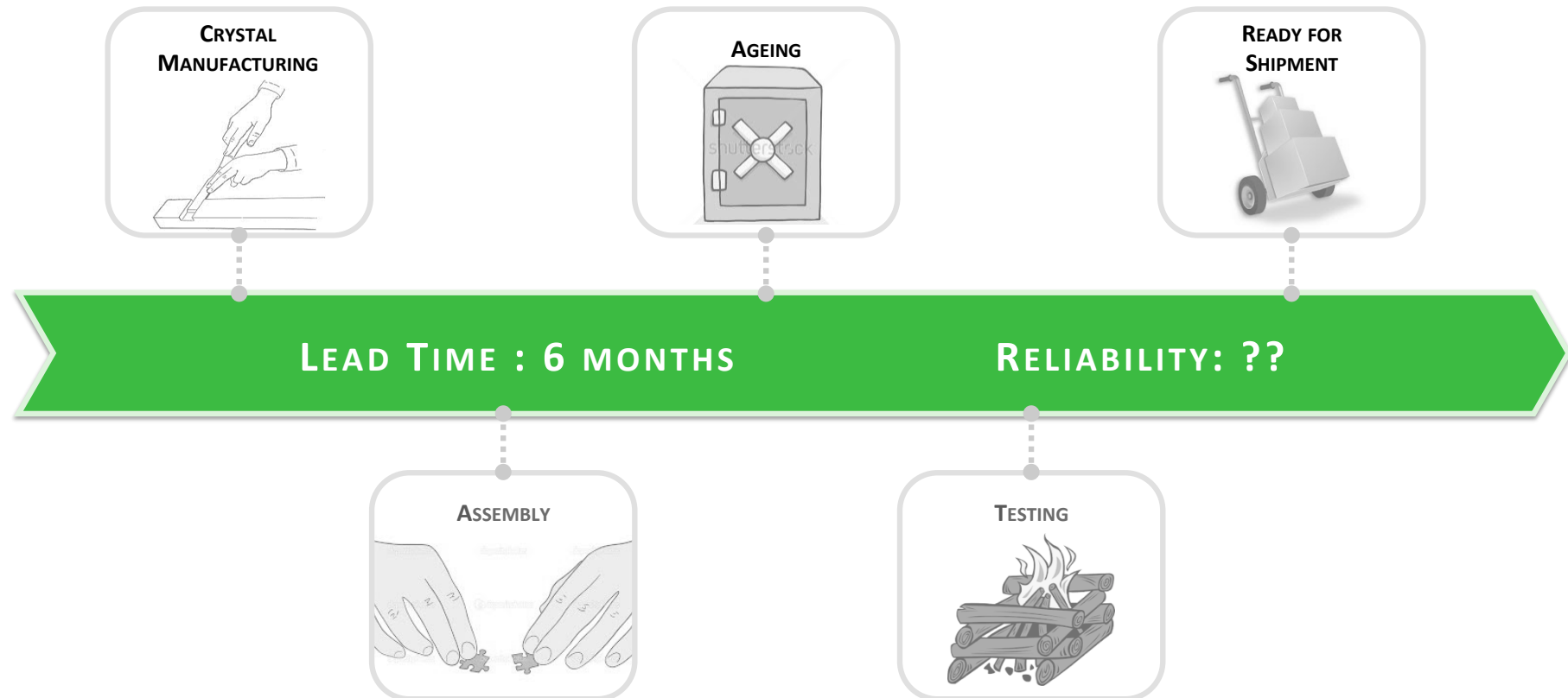
Evolution of Oscillators

rakon

◀ Temperature Stability vs Price



Key Issues With Oscillators



IC OCXO vs Discrete OCXO

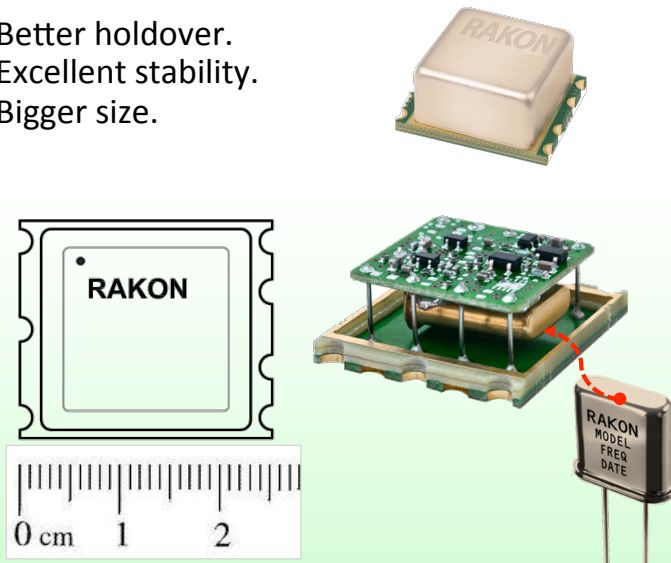
rakon

- ◀ The IC OCXO integrates the discrete components of a traditional OCXO onto an ASIC.

Discrete OCXO

25.4 x 22 mm

- ◀ Better holdover.
- ◀ Excellent stability.
- ◀ Bigger size.



Package

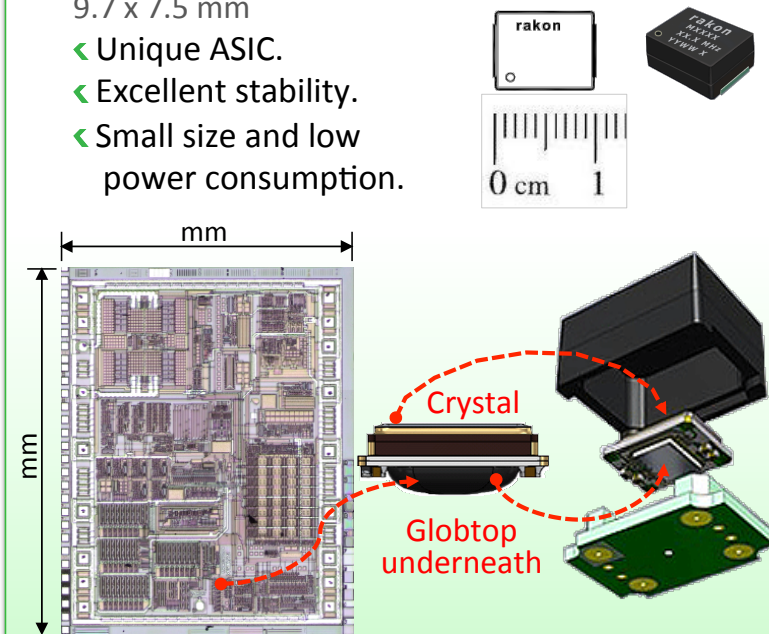
Assembly

VS

IC OCXO

9.7 x 7.5 mm

- ◀ Unique ASIC.
- ◀ Excellent stability.
- ◀ Small size and low power consumption.



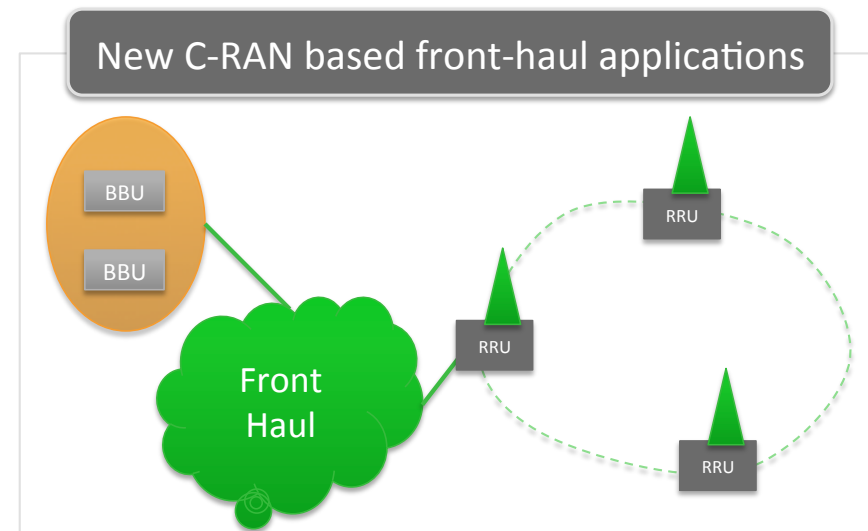
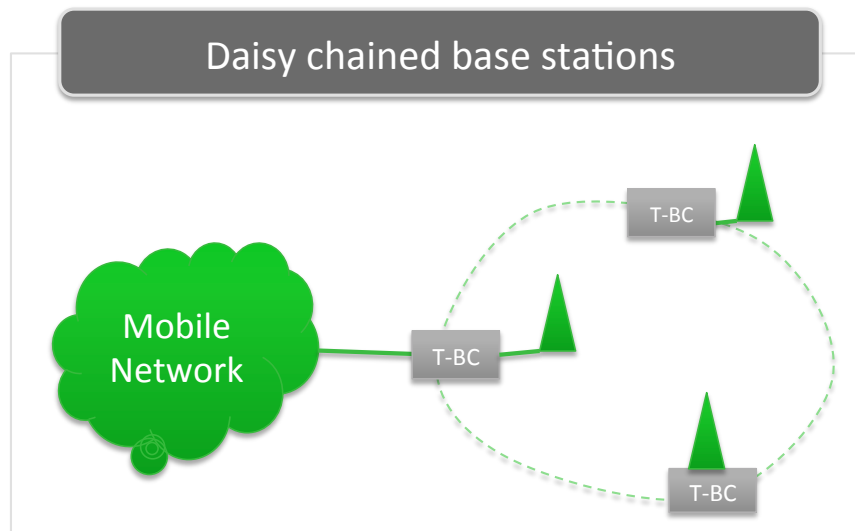
DIE

Assembly

Enhanced Ethernet Equipment Clock (eEEC)



- ◀ Leverage on new generation Oscillators
- ◀ Improved wander generation capabilities
- ◀ Improved Holdover Capabilities – Cell router with Sync Capabilities



Environmental Aspects



< Temperature Effects

- ❑ Testing for ruggedness and temperature recycling Vs testing for sync performance
- ❑ Temperature testing regime

< Airflow Effects

- ❑ Impact of characterized airflow effects (fans etc.)
- ❑ Impact of un-characterised filed effects (Opening the cabinets)

Environmental Aspects



◀ All Oscillators are traditionally designed to work on still air

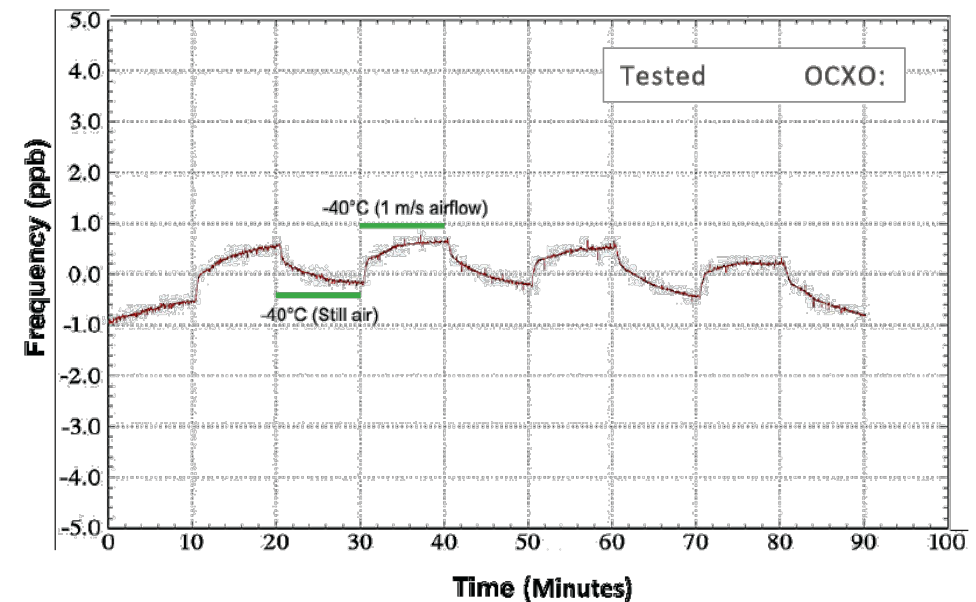
◀ Heat generating/removing elements are not Oscillator friendly

◀ Recommended methods

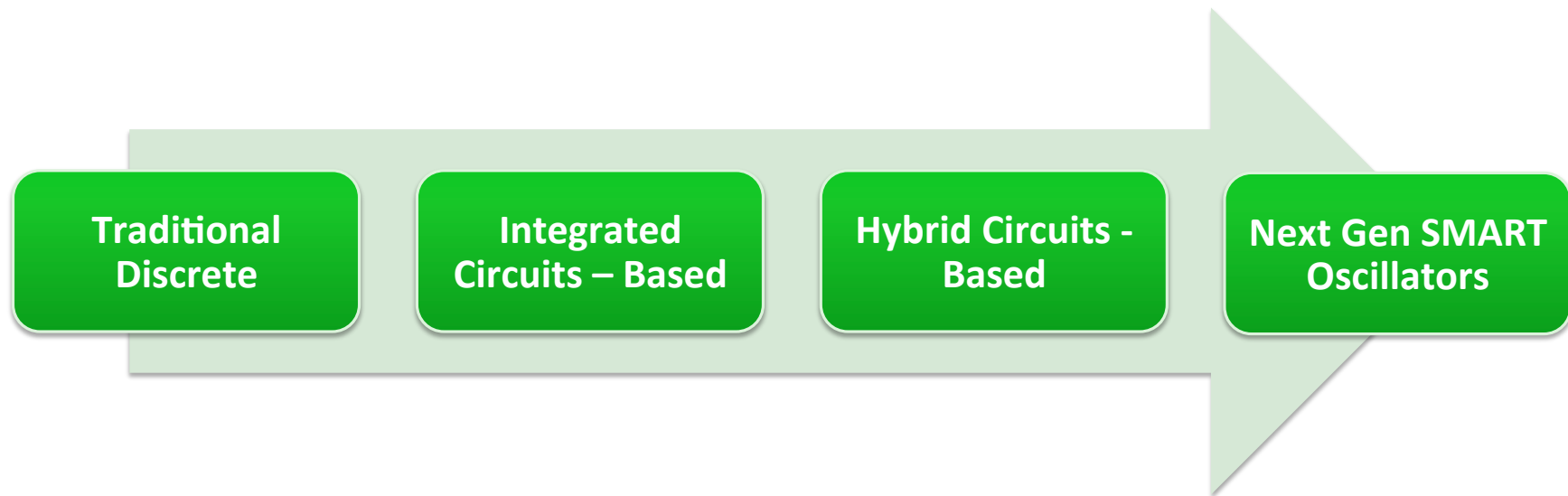
- ❑ Thermal isolation
- ❑ Isothermal shields

◀ Airflow effect on temperature stability

- ❑ Example frequency deviation plot



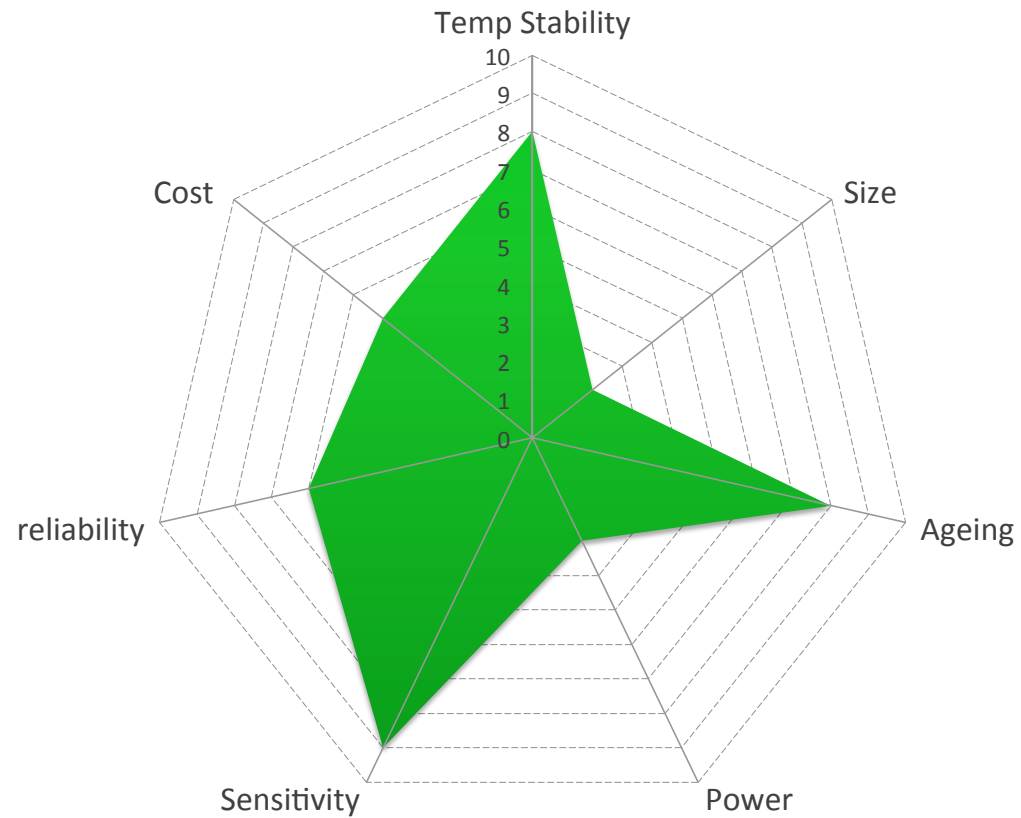
Oscillator Technology Evolution



Each technology is Unique

rakon

Discrete

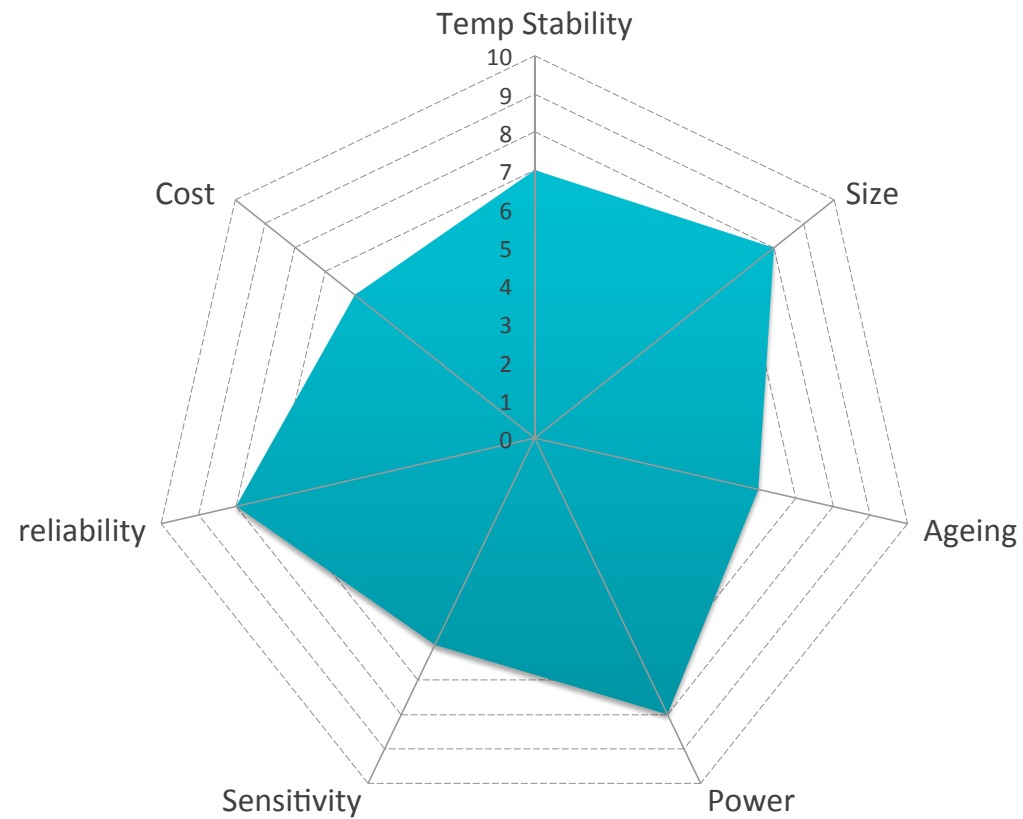


■ Discrete

Integrated Circuits Based

rakon

IC Based

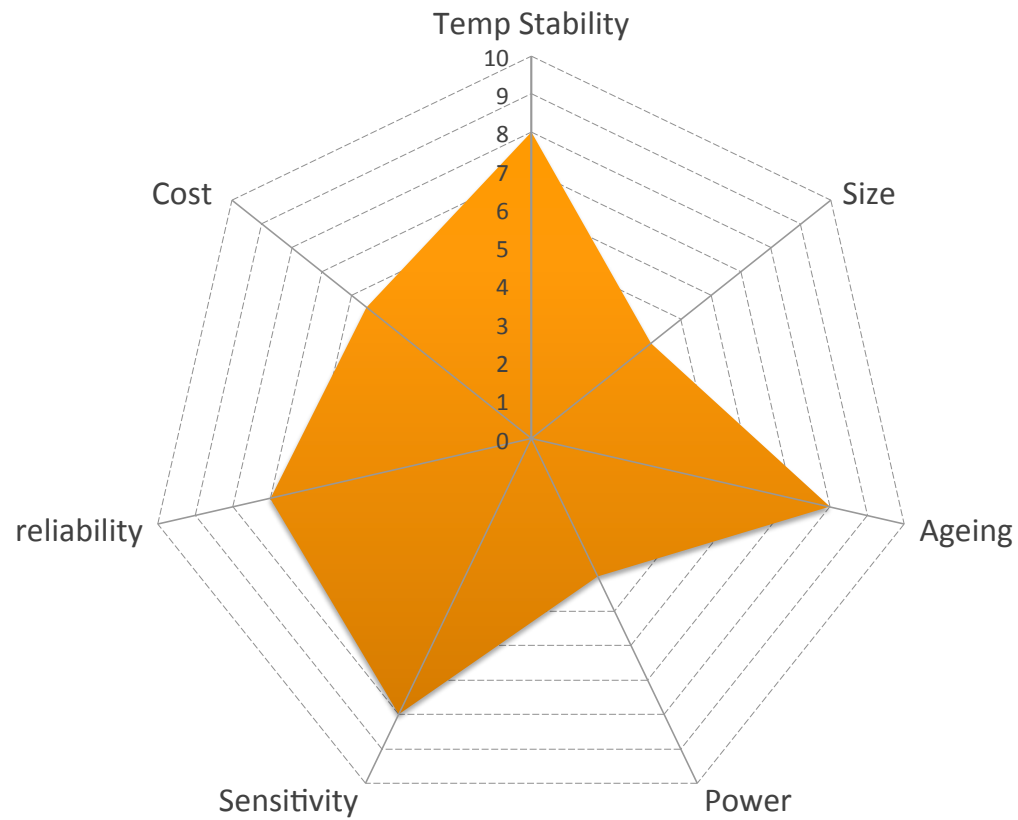


■ IC Based

Hybrid Technology



Hybrid

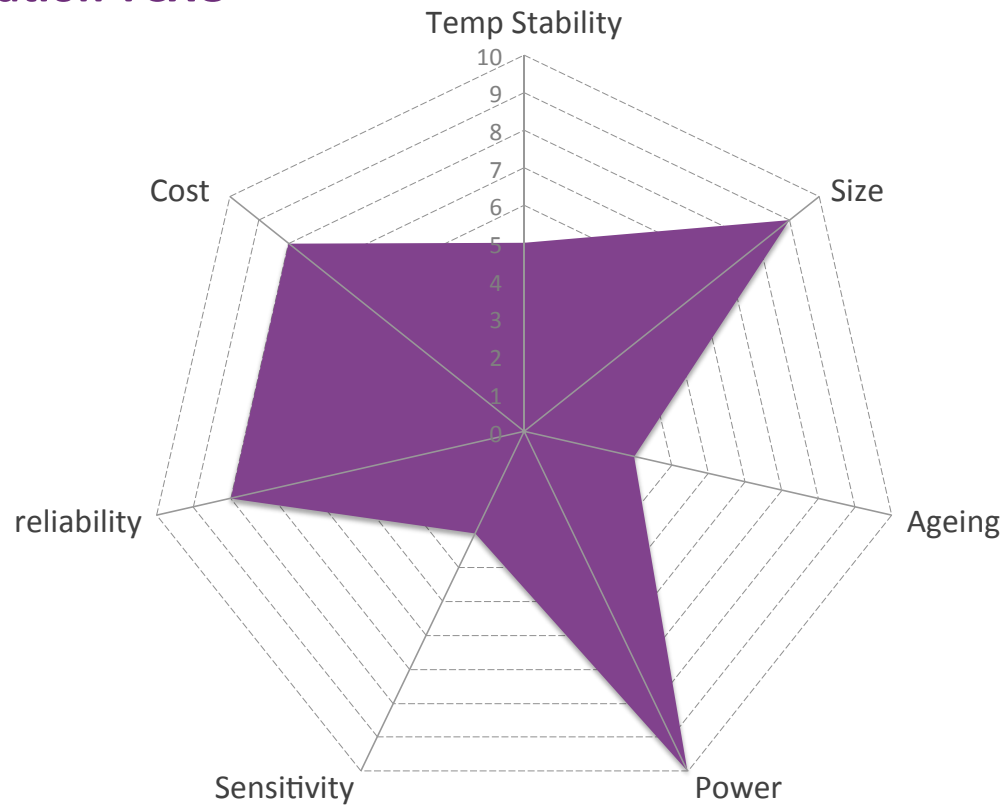


■ Hybrid

Next Gen SMART Oscillators



Next Generation TCXO



■ Next Gen TCXO

Future Trends

**1**

Digital Interfaces

- I²C Interfaces for frequency control

2

High Frequency Multi-Output Oscillators

- Platforms for Soft-Servo Controls

3

Extreme temp ranges

- For Industrial and other applications

4

System support for OCXOs

- 1 PPS Input/Output OCXOs

Acknowledgement

Dr. Nigel Hardy

– Principal Design Engineer, Rakon UK Limited

CONFIDENTIAL INFORMATION

rakon

