



DECT Coordination with Bolero

What is DECT?

- Digital Enhanced Cordless Telecommunications
 - Standard Primarily used for Cordless Telephone Systems
 - Near Global License Free Standard for Bi-Directional Wireless Communications operating in the 1.9GHz frequency range

- DECT in the US
 - DECT Range in the US is 1.92-1.93
 - 100mW Peak, 4mW Average
 - 5 Total Carriers
 - 10 Usable Timeslots

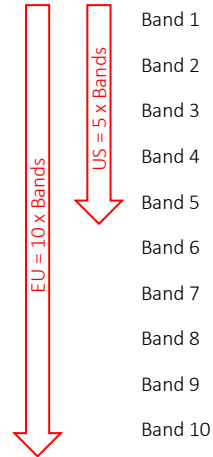
DECT Timeslot Overview

THE DECT SPECTRUM IS BROKEN UP INTO FREQUENCY BANDS

IN THE EU, WE ARE ALLOCATED 10 FREQUENCY BANDS

IN THE US, WE ARE ALLOCATED 5 FREQUENCY BANDS

Frequencies



DECT Timeslot Overview

FOCUSING ON THE US FREQUENCY BANDS...

THE 5 BANDS ARE BROKEN UP INTO 12 TIMESLOTS EACH

Frequencies

DECT Timeslots

Band 1	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Band 2	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Band 3	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Band 4	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Band 5	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12

DECT Timeslot Overview

How Does Riedel Bolero Use these timeslots?

Frequencies	DECT Timeslots											
Band 1	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
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Band 5	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12

Bolero uses 1x timeslot for each 7KHz intercom port

1 TIMESLOT = 1 BELTPACK

AS PER THE DECT PROTOCOL, THE BELTPACKS WILL
HOP TIMESLOTS AND FREQUENCY AS NEEDED

DECT Timeslot Overview

How Does Riedel Bolero Use these timeslots?

ALL WHILE IMPOSING 256 BIT AES ENCRYPTION*

Frequencies

DECT Timeslots

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For reliable handover
2x timeslots
Are reserved

Bolero uses 1x timeslot for each 7KHz intercom port

1 TIMESLOT = 1 BELTPACK

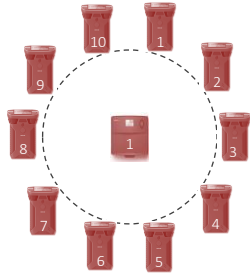
**Breaking a symmetric 256-bit key by brute force requires 2^{128} times more computational power than a 128-bit key. Fifty supercomputers that could check a billion billion (10^{18}) AES keys per second (if such a device could ever be made) would, in theory, require about 3×10^{51} years to exhaust the 256-bit key space.*

AS PER THE DECT PROTOCOL, THE BELTPACKS WILL
HOP TIMESLOTS AND FREQUENCY AS NEEDED

Capacity in a Pure DECT Environment

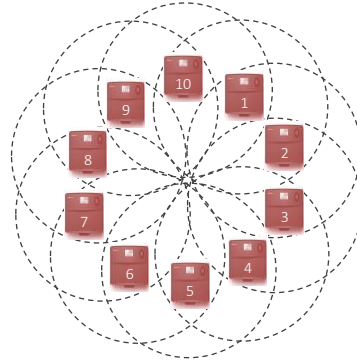
- Pure Environment is one where a single manufactures DECT-based devices exist – there are no other 3rd party devices such as cordless phones or other DECT-based intercom systems operating
- 5 Key Factors
 - Number of Frequency Bands
 - Number of Antennas in a system
 - RF overlap of Antennas
 - Maximum Antenna Count per given area
 - Interference

System Capacity – Number of Antennas in a System and RF Overlap



Antenna Space

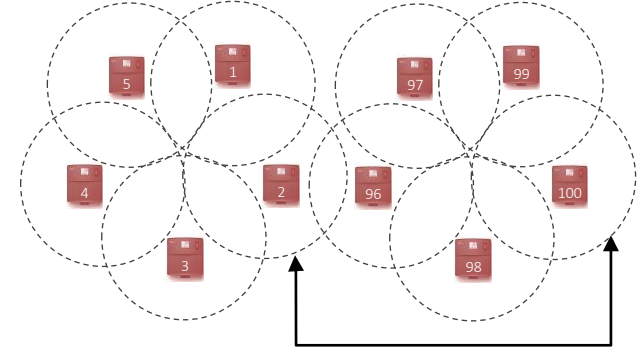
- 10 x beltpacks per antenna



One radio area

Near Field Antenna Spacing

- (e.g. all antennas on same place, 100% antenna overlap)
- 50 x antennas / 100 beltpacks (in overlapping RF space in EU)
- 25 x antennas / 50 beltpacks (in overlapping RF space US)



These non-overlapping antennas can use the same frequency

Bolero Network Space (NET)

Near Field and Far Field Antenna Spacing

(distributed antennas, non 100% overlapping radio areas)

- 100 x antennas in a NET (EU & US)
- Up to 250 x beltpacks in a NET (EU & US)

A Bolero System “Net” supports

Integrated/Artist:

100 Antennas and **250** beltpacks

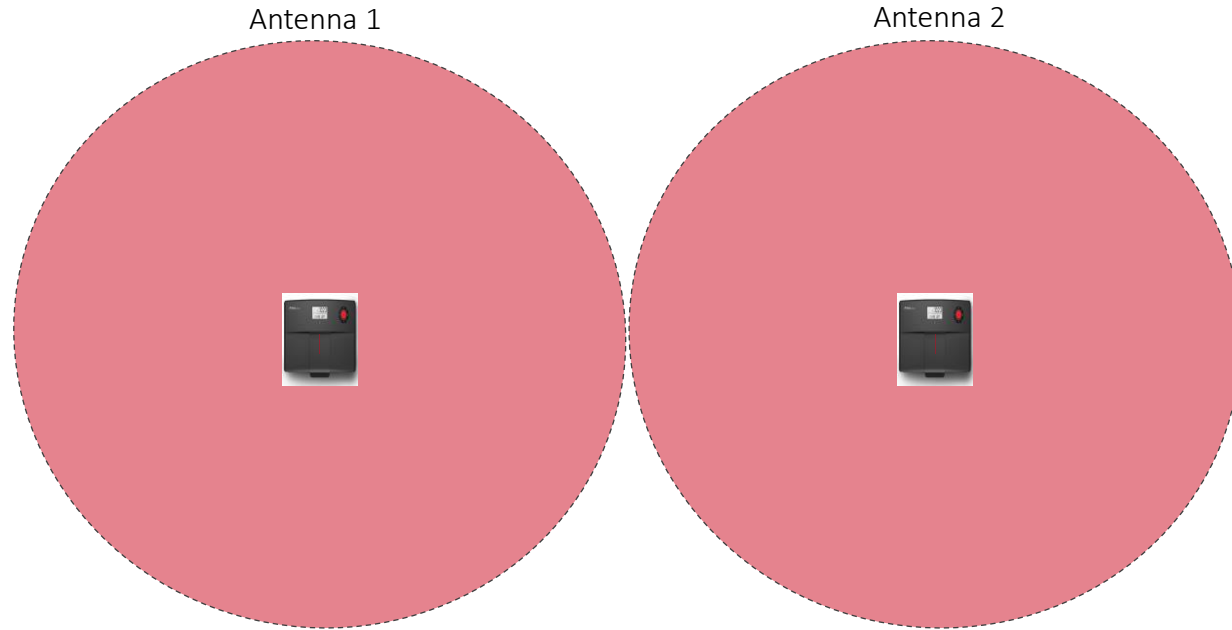
Standalone/2110:

100 Antennas and **100** beltpacks

Standalone/LINK:

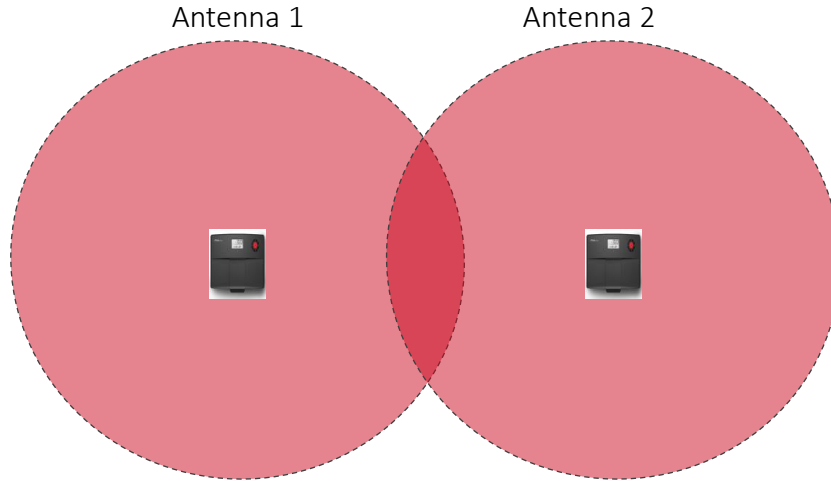
100 Antennas and **100** beltpacks

Overlap of Antennas – No Overlap

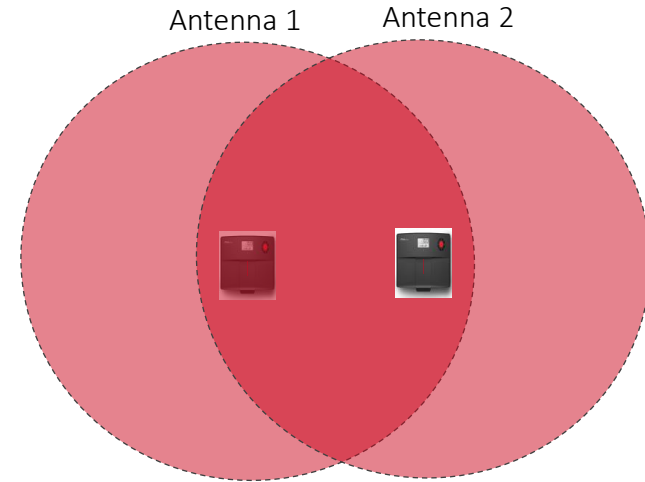


- Maximum Coverage Outdoor (Free line of sight) – Maximum 300m (Approximately 1000')
- Around -75dBm to -80dBm the system will look for handover
- Zero Power Overlap. 100% of the timeslots and frequency re-use possible

Overlap of Antennas – With Overlap



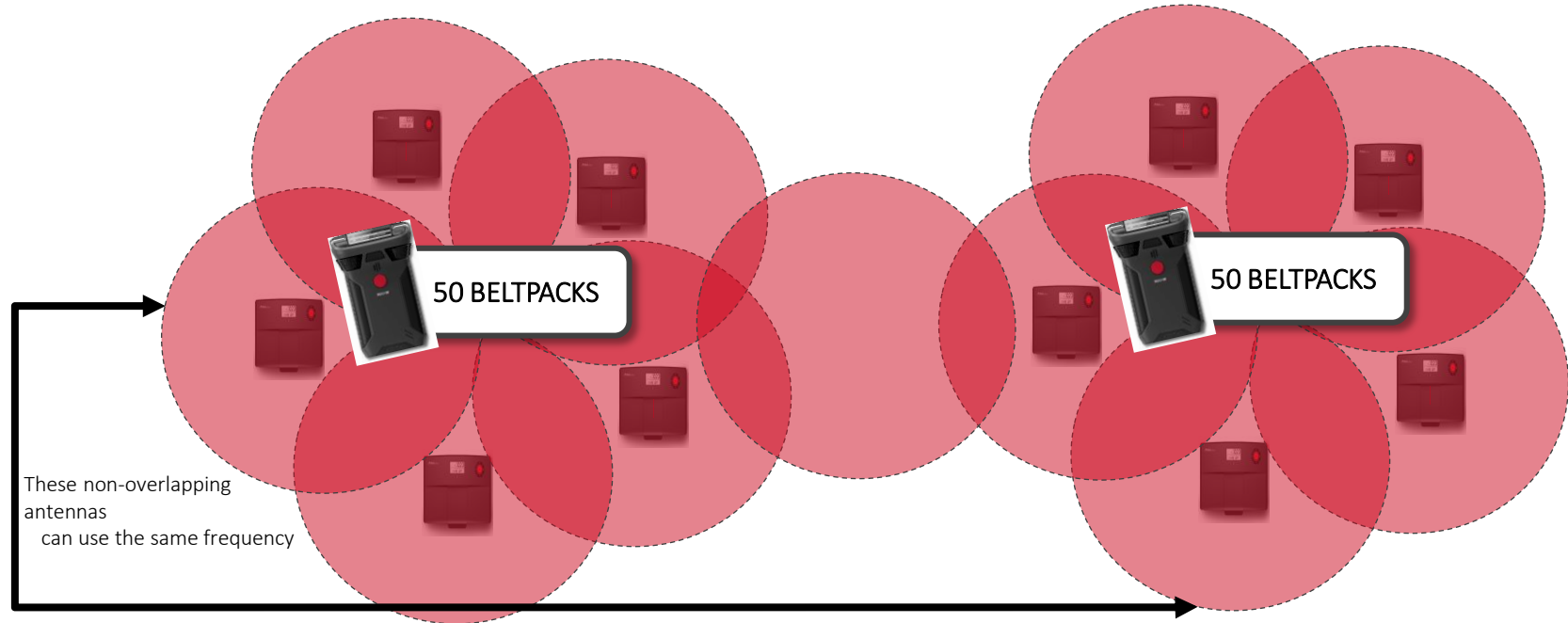
Power Separation is greater than 15dB at approximately 120' of Separation or more



Power Separation is less than 15dB therefore antennas cannot re-use the same frequencies and timeslots

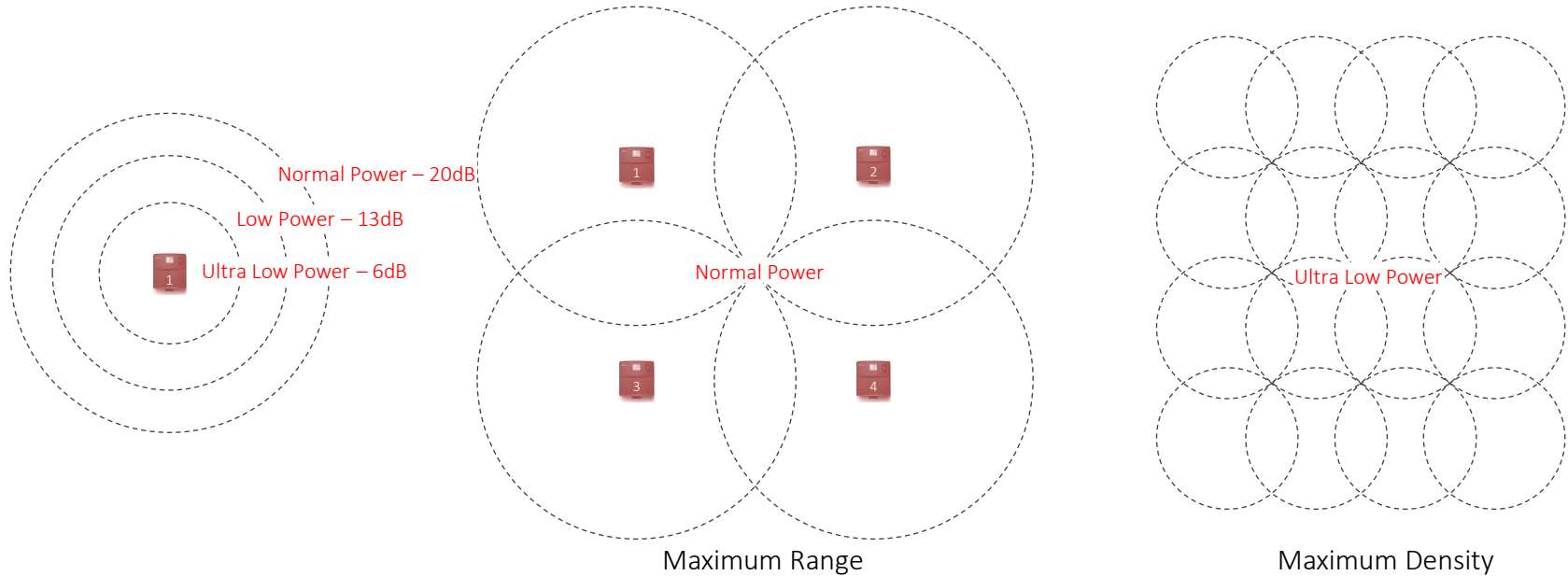
- The Magic Number is approximately 15dB of power separation
 - If the power separation is greater than 15db they will not interfere with each other
 - If the power separation is less than 15db antennas cannot re-use the same frequencies

Growing a System beyond 50 Beltpacks



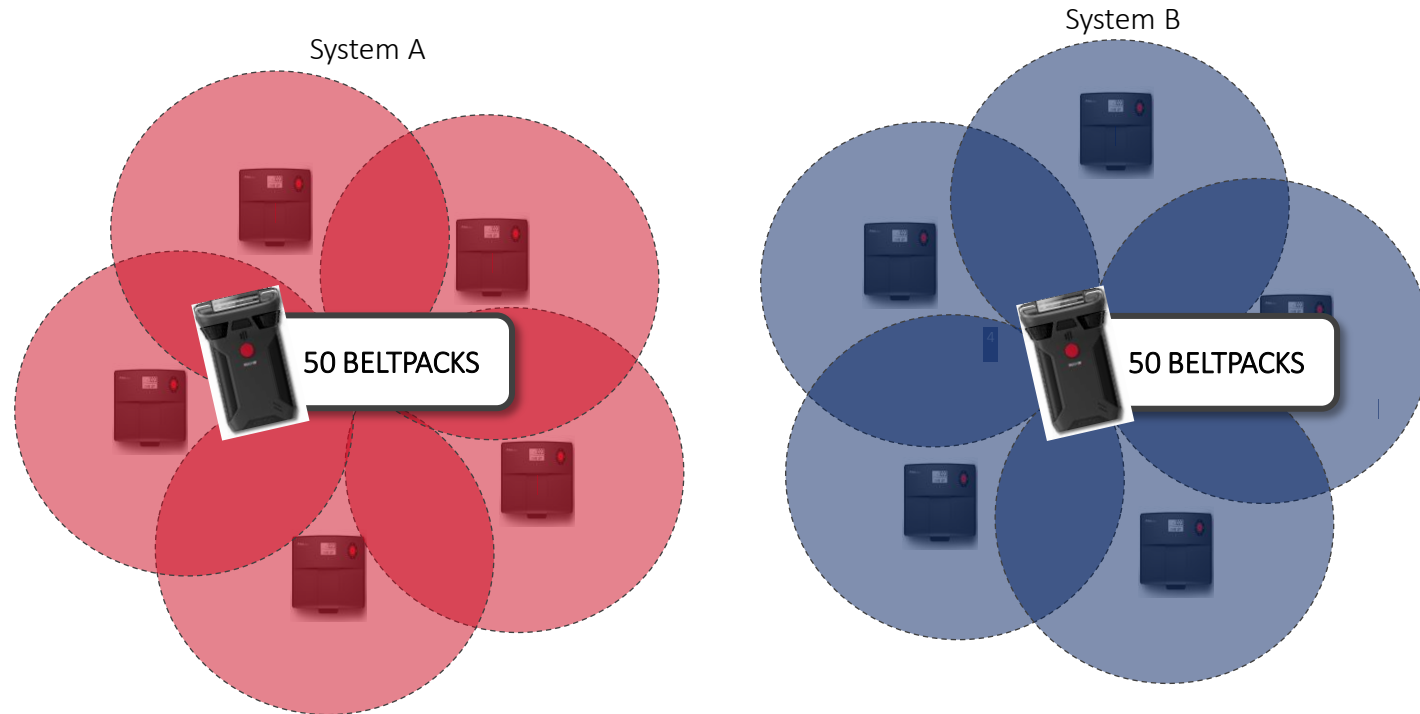
- Taking what we learned about Antenna Spacing use Walk Test mode and Walk Test Pro on your Beltpack to find the magic number of 15dB of separation to place your next antenna
- But what if the Venue is too small to achieve this separation?

Bolero Programmable RF Power Advantage...



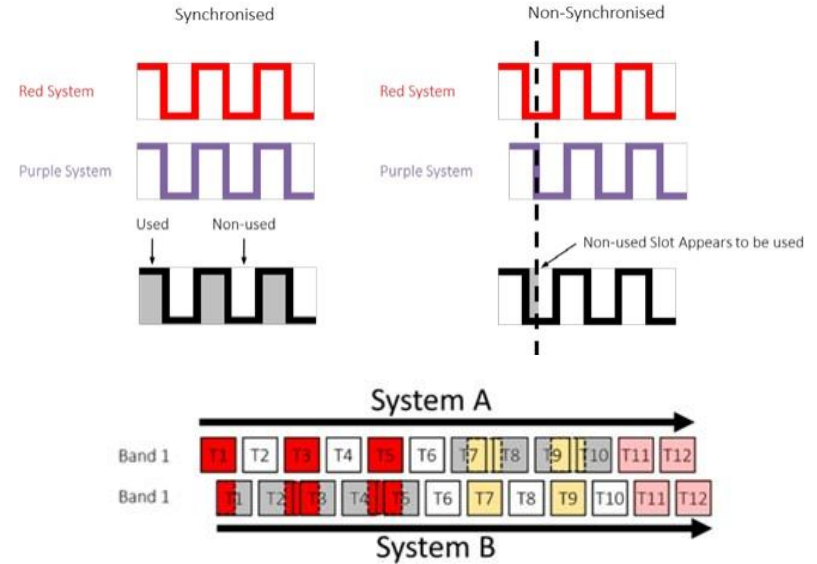
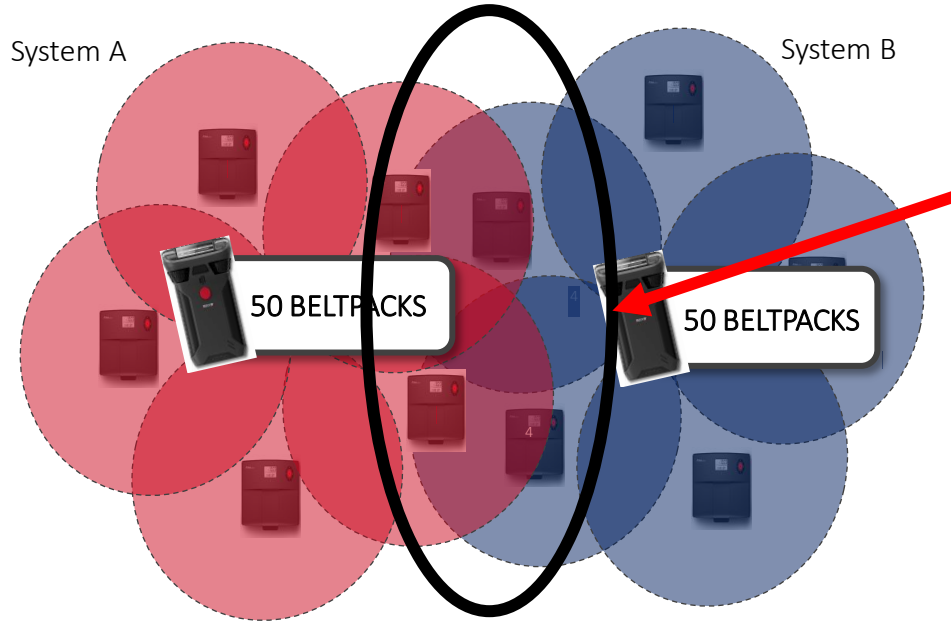
- Bolero antennas have programmable output power
- Reducing power allows higher antenna density and more Beltpacks in a given space

Separate Systems and Synchronization



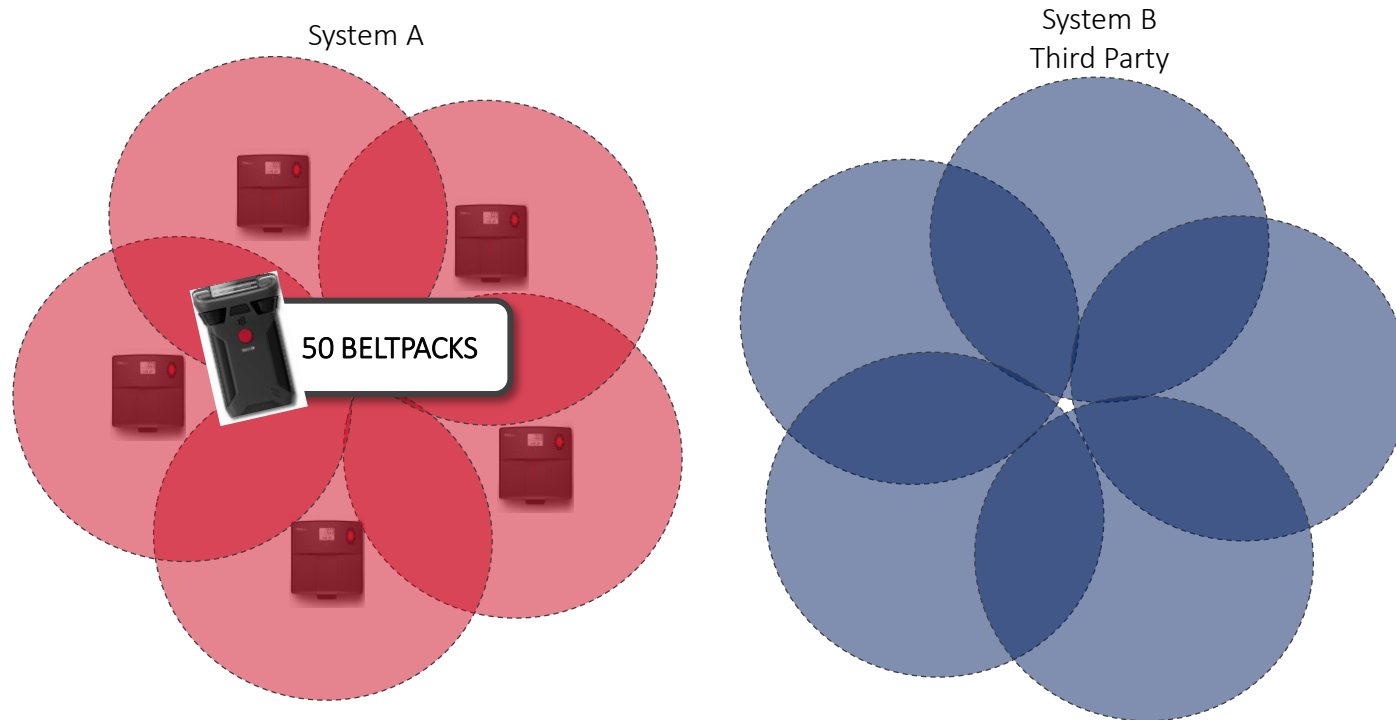
- If System are isolated enough from Each Other there are no synchronization issues

Separate Systems and Synchronization



- Sync Both System A and B to the same External Clock to solve any synchronization issues
- Any Bolero antenna from either system will work as a Master Clock to solve this issue
Keep in mind a single bolero antenna can clock up to 32 devices on a Network (panels, Cards, Antennas)

Separate Systems and Synchronization – Bolero With 3rd Party Systems



- When using Bolero with a 3rd Party system to your best to eliminate overlap otherwise misalignment could result in lower capacity if system cannot be managed by an external clock

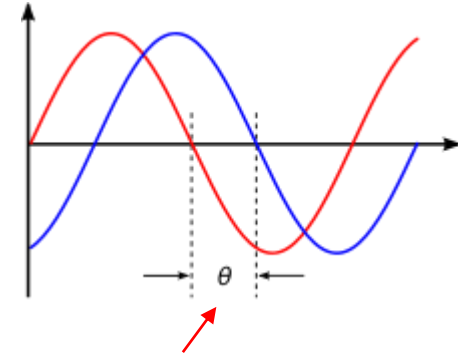
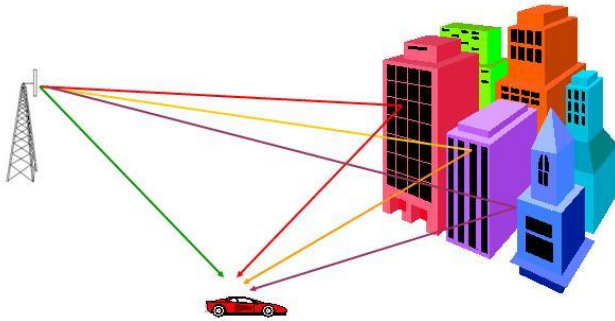
Multipath Tolerance



Riedel unique ADR technology enables Bolero to achieve

- best in class radio reflection tolerance
- most reliable radio performance

Multipath Reflection Effects



Phase shifts can create "constructive" and "destructive" interference

*Multipath interference is where a **wave** from a source travels to a detector via **two or more** paths and components of the wave **interfere**.*

*Multipath interference is a common cause of "**ghosting**" in transmission systems.*

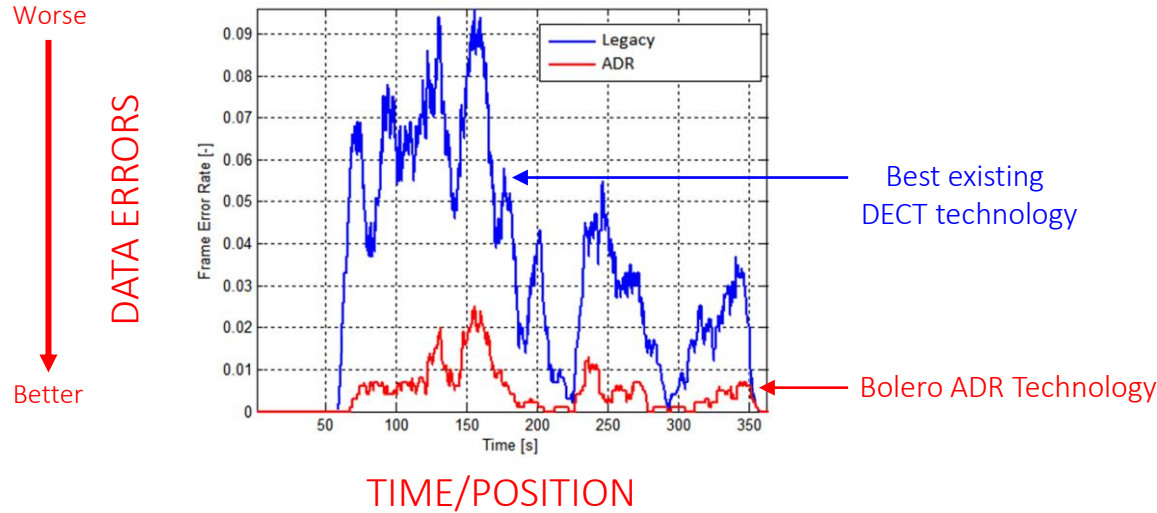
- Multipath effects create artefacts, audio dropouts & poor RF reliability

Riedel ADR Advanced DECT Receiver

*Riedel has developed a “UNIQUE” DECT receiver that can differentiate between **multipath reflections** to cancel **group** and **phase delay** increasing the signal to noise ratio of the RF layer.*

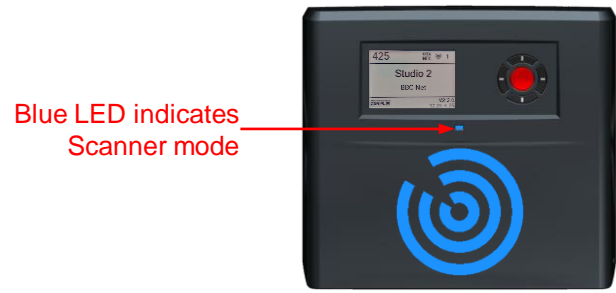
- The ADR is a real time process that allows Bolero to continuously adapt to changing RF reflection environments.
- It improves frame error and bit error rates of the received signal significantly.

Bolero overcomes reflections with the unique Advanced Receiver Technology



- Bolero ADR makes wireless useable in **highly challenging** reflective environments

RF Monitoring with Bolero's Advanced RF Monitoring App



**Antenna
Radio Scanner**

and



**Beltpack
Radio Monitoring**

RF Scanners – Traditional Scanners

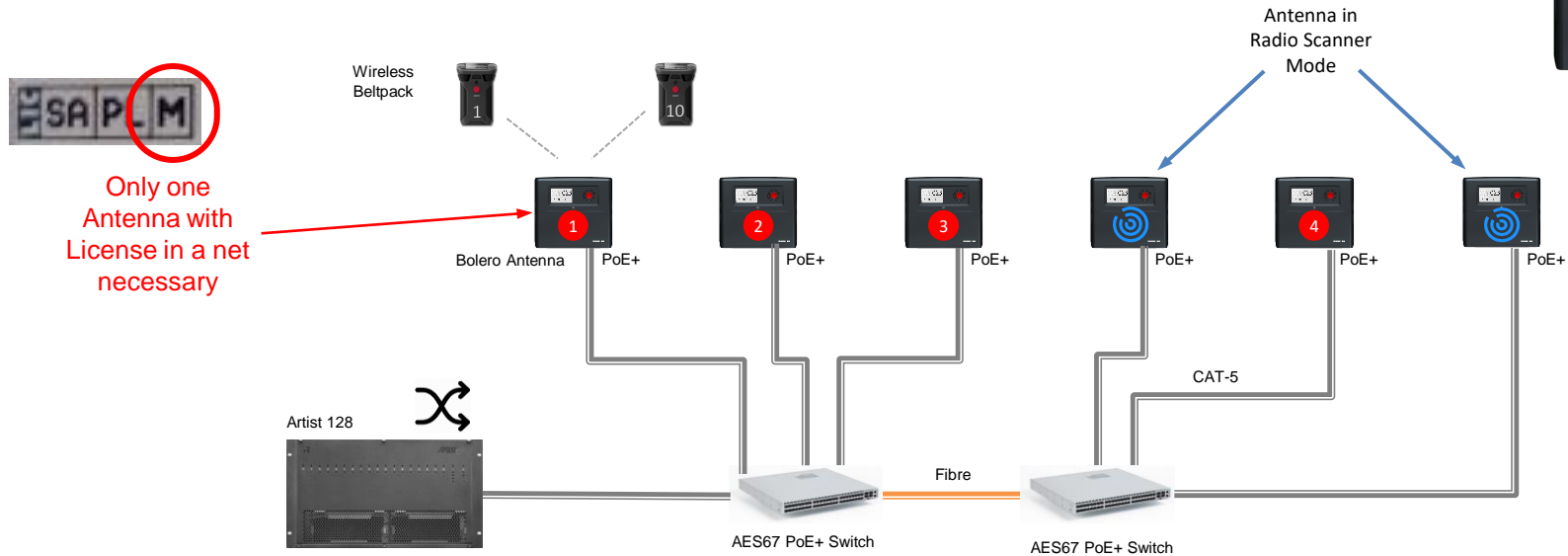
- Benefits

- See entire RF environment
- See above and below DECT space
- Verify any bleed from Cell Towers coming into the DECT Space
- Better Visual on Noise Floor

- Cons

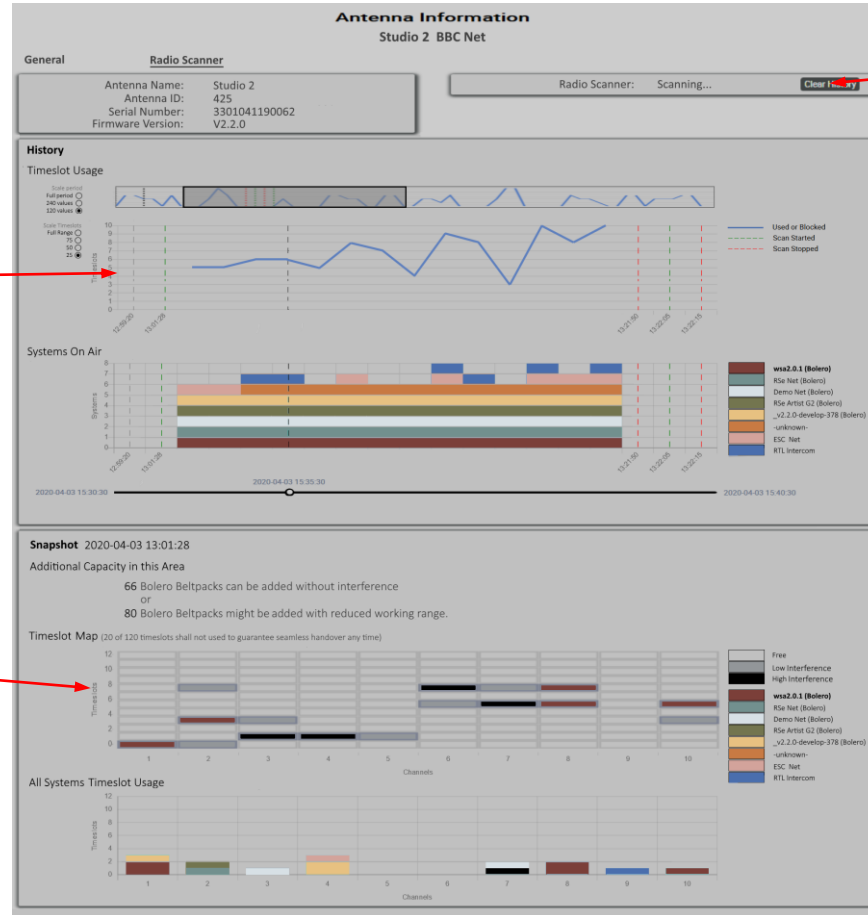
- Cannot see details on a Time Slots Basis
- Can only see the 5 frequency bands of DECT
- Cannot differentiate between separate DECT Systems

Antenna Radio Scanner



- Bolero antennas can be configured for continuous radio scanning the RF environment
- Scan data stored in antenna locally (approx. 1 scan/min => 1440 / day)
- 3 days are able to be stored

Antenna Radio Scanner View



History section

Start / Reset Scan

Snapshot section



Antenna Radio Scanner View – History Section Overview

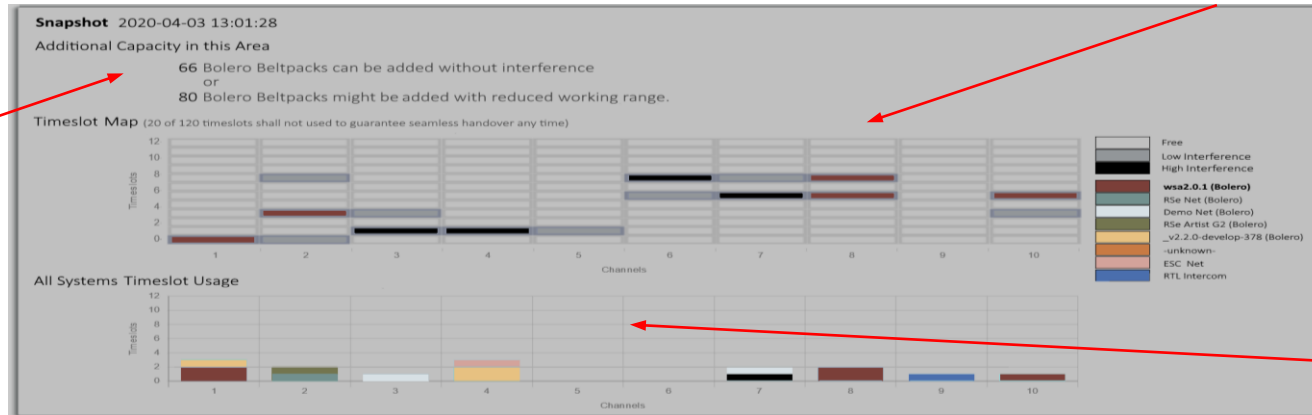
- Radio history can be logged to show changes during an event
- History section to show and scroll to a part of the timeline
- Timeslot Usage
 - Shows the number of timeslots used by Bolero or interfered by other devices
- Systems On Air
 - Identifies all Bolero and other DECT systems On Air





Antenna Radio Scanner – Snapshot Overview

- Snapshot shows detail Information of a measurement in the timeline
- Additional Capacity
 - Shows how many Beltpacks may still added to the radio area of the antenna
- Timeslot Map
 - Shows used capacity and unusable capacity due to interference
- All System Timeslot Usage
 - Shows which frequency is used by the different DECT systems
 - Shows if a frequency is completely interfered by DECT devices not recognized



Used Timeslots of a snapshot

Additional Capacity

Frequency Channel usage

Beltpack Radio Capacity Warning



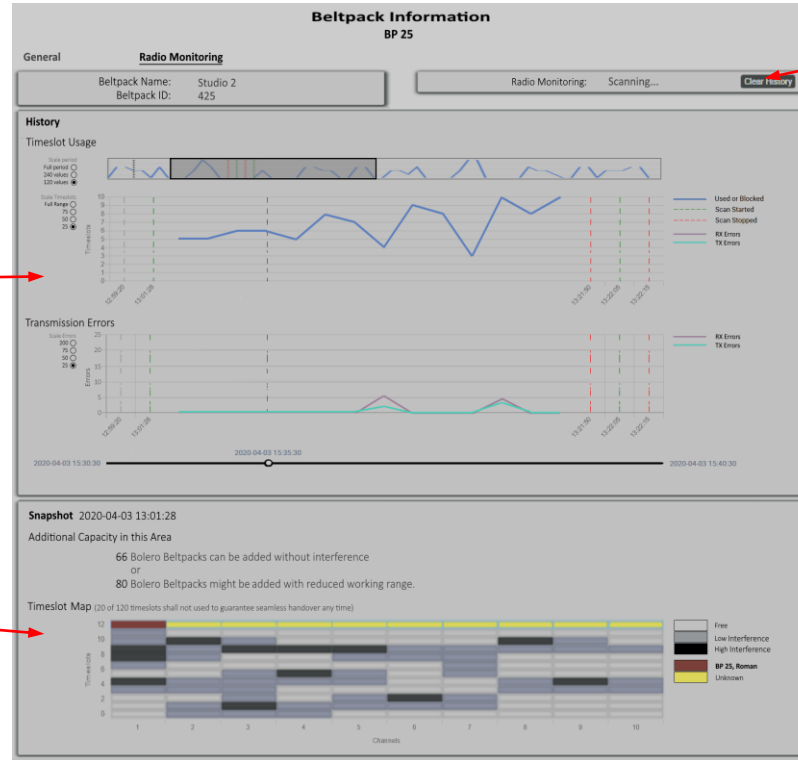
- The Beltpack measures all timeslots continuously (number of free, usable or occupied timeslots)
- If a warning threshold is crossed (e.g. less than 3 remaining timeslots) the Beltpack automatically sends a BP spectrum warning message to the WebUI

Antennas IO Devices <u>Beltpacks</u> Profiles Partylines Audio Channels Triggers						
BOLERO						
Status	Name	ID	Profile	Last Conn.	Direct Edit:	
	BP 1	1	Demo Profile	2019-08-27 16:35:11		
	BP 2	2	Demo Profile	2019-09-24 14:28:37	Bolero 13	
	BP 3	6	Demo Profile	2019-08-27 17:18:36		
	BP 4	7	Demo Profile	2019-07-19 11:49:30		
	BP 6	8	Demo Profile	2019-08-13 17:05:03		
	BP 7	9	Demo Profile	2019-08-13 17:05:05		

Warning if not enough timeslot are available for secure operation

Beltpack Radio Monitoring View

NEW



History section

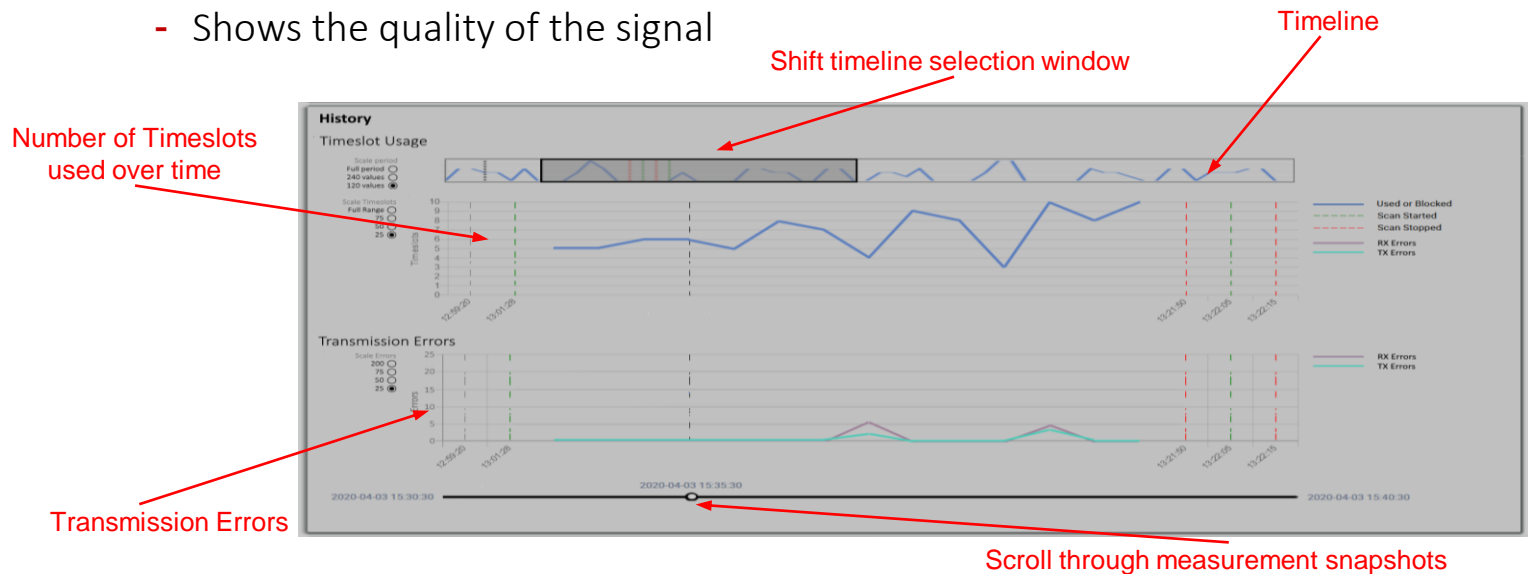
Snapshot section

- Up to five beltpacks can be selected for continuous detailed monitoring of the RF environment



Beltpack Radio Monitoring View – History Section

- Radio history can be logged to show changes during an event
- History section to show and scroll to a part of the timeline
- Timeslot Usage
 - Shows the number of timeslots used by Bolero or interfered by other devices
- Transmission Errors
 - Shows the quality of the signal





Beltpack Radio Monitoring View – Snapshot Overview

- Snapshot shows detail Information of a measurement in the timeline
- Additional Capacity
 - Shows how many Beltpacks may still added to the radio area of the beltpack
- Timeslot Map
 - Shows used capacity and unusable capacity due to interference



Used Timeslots of a snapshot

Advanced RF Monitoring App DEMO



**Antenna
Radio Scanner**

and



**Beltpack
Radio Monitoring**

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Thank You!