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Successful Strategies for Integrating Bluetooth™ into a Cellular Telephone

April 15, 2003

presented by:
Tim Masson,
Agilent Technologies

Agenda

- Overview
  - Why integrate
  - Design options
- Co-existence issues & solutions
  - Power
  - Electromagnetic compatibility
  - Manufacturing strategy
- Summary

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Why integrate Bluetooth

- Cordless headset
- Virtual car-kit / hands-free phone
- Information exchange,
  synchronisation of personal databases
- Wireless connection to modem functionality
  GPRS data service

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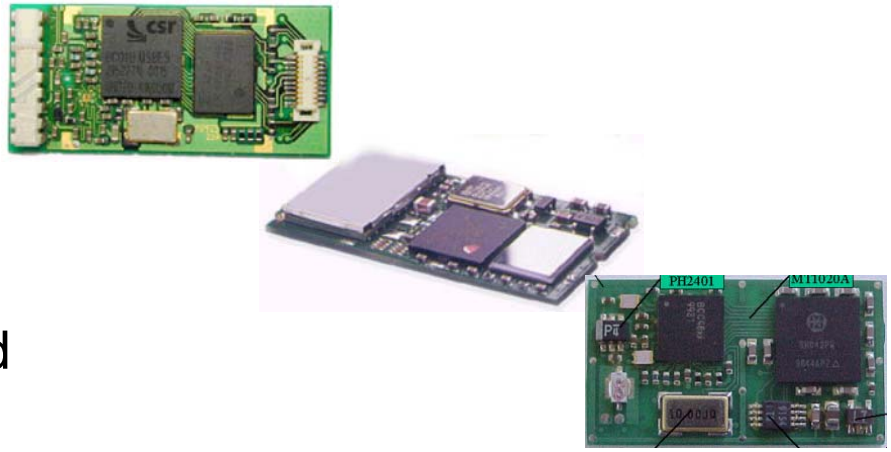
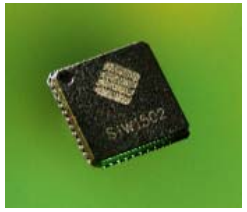
Bluetooth™ Implementations

Design decisions

- Battery Pack or “Dongle”
- Pre-manufactured module
- Components on shared PCA
- Separate or shared Baseband





….have implications for:

- Where test happens
- What has been tested already
- Control & measurement interfaces

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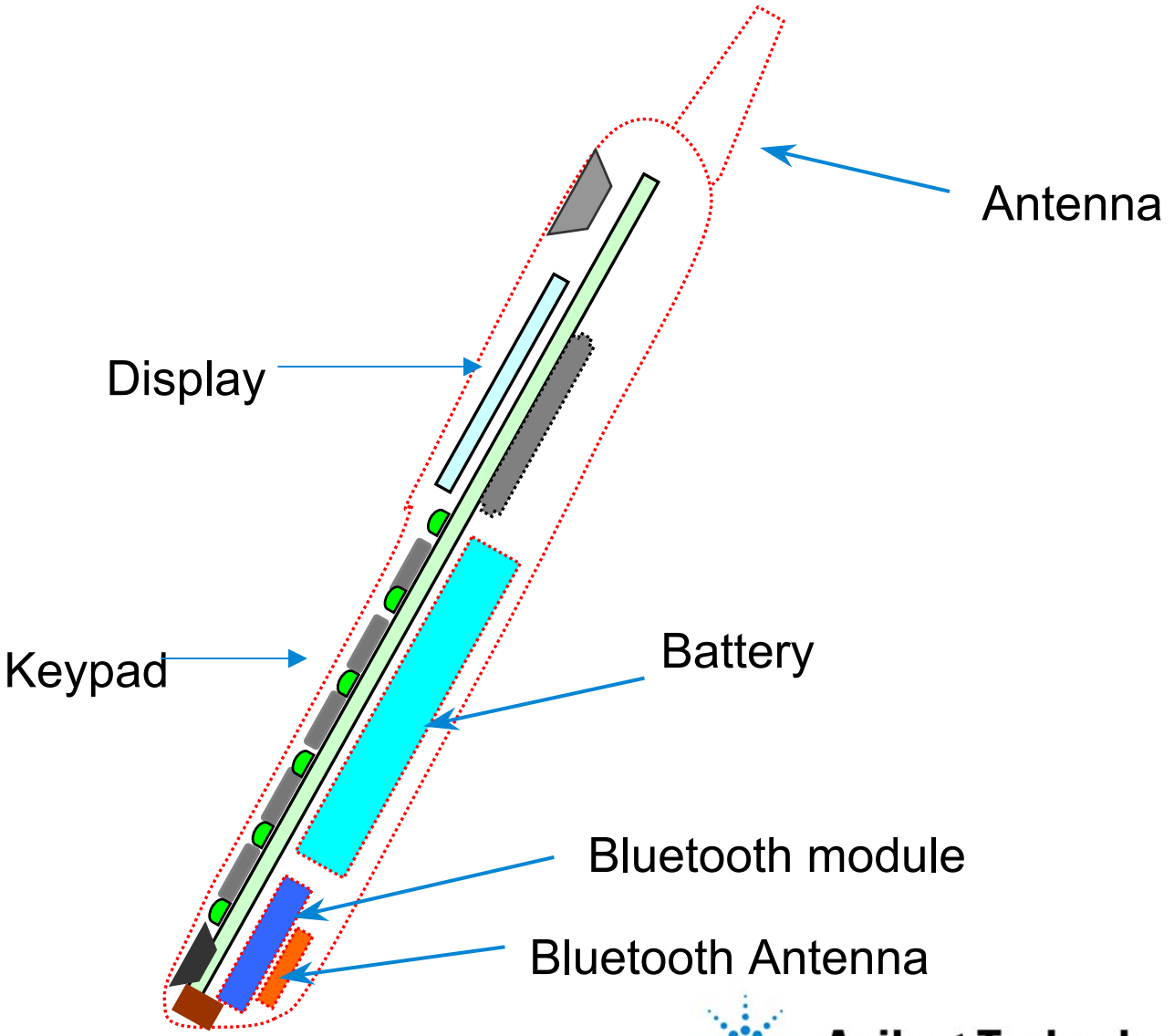
Bluetooth placement



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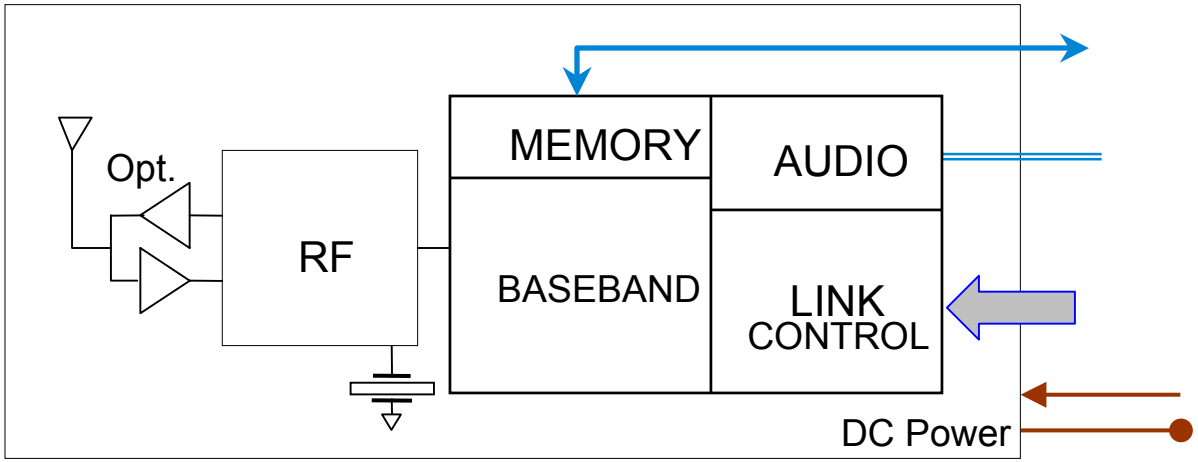
Anatomy of a Bluetooth module



What needs calibration?

- Frequency
- Modulation
- Power
- Audio

What data is accessible?

- Identity/address
- Calibration constants

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GSM and Bluetooth co-existence

- Power supply can couple switching noise between the two transceivers
  - Decoupling will be required
- Digital processing interface can couple switching noise between the two transceivers
- RF bursting generates unwanted signals within the system
  - Shielding may be required
  - Balanced circuitry may be needed. This reduces effects of common-mode signals

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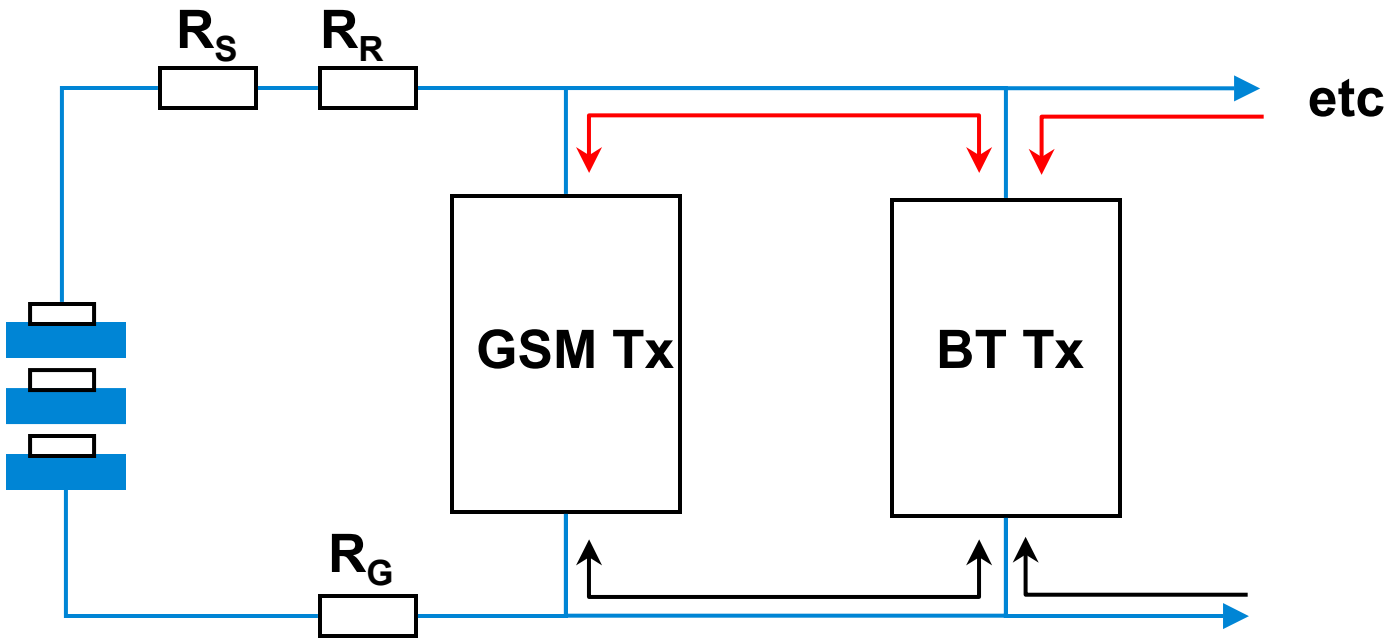
Effect of battery & rail resistance

Power distribution



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GSM & Bluetooth transmissions

GSM TDMA multiplex

Bluetooth TDD multiplex

GSM Tx current

Bluetooth Tx current

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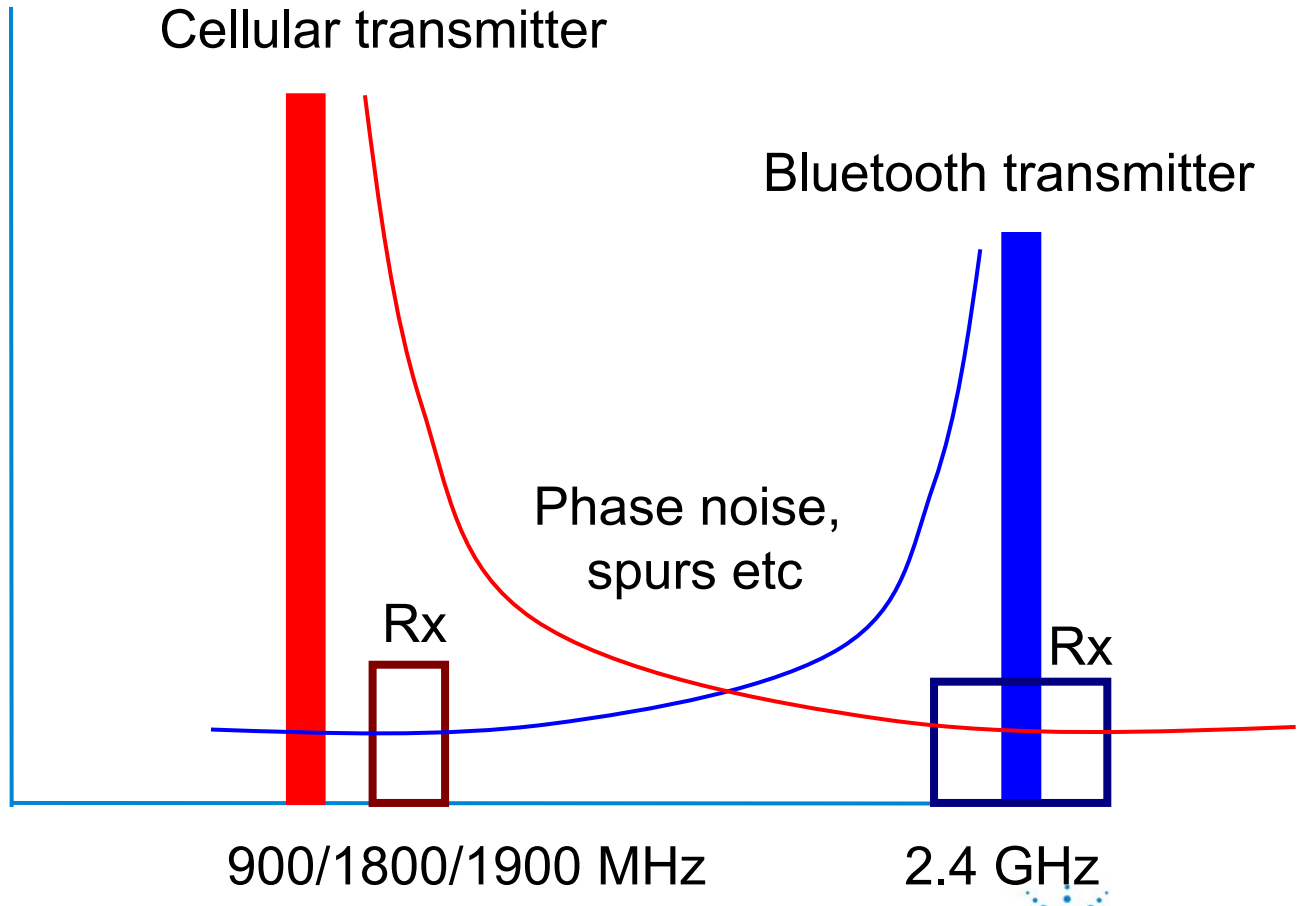
Bluetooth/Cellular co-location

RF Issues



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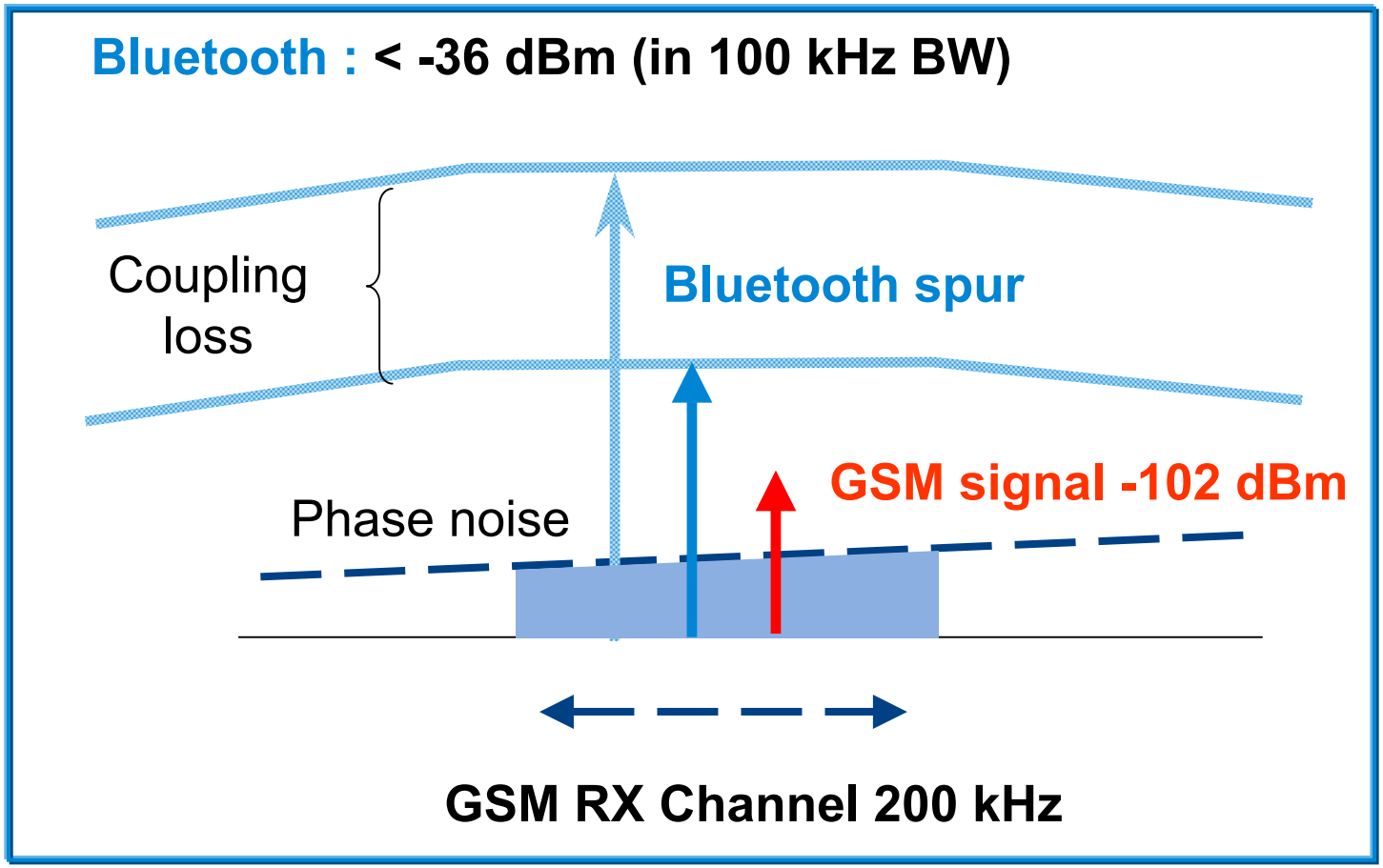
GSM and Bluetooth co-existence

Electromagnetic compatibility

- Can cellular transmissions exceed Bluetooth receive spurious specifications?
- Could GSM transmitter spurious (within the GSM specification) desensitize the Bluetooth receiver?
- Could Bluetooth transmitter spurious interfere with the cellular receiver?
- Can the Bluetooth transmission desensitize the cellular receiver?

Spurious Desensitization – 1

Bluetooth spurious can de-sense a GSM receiver



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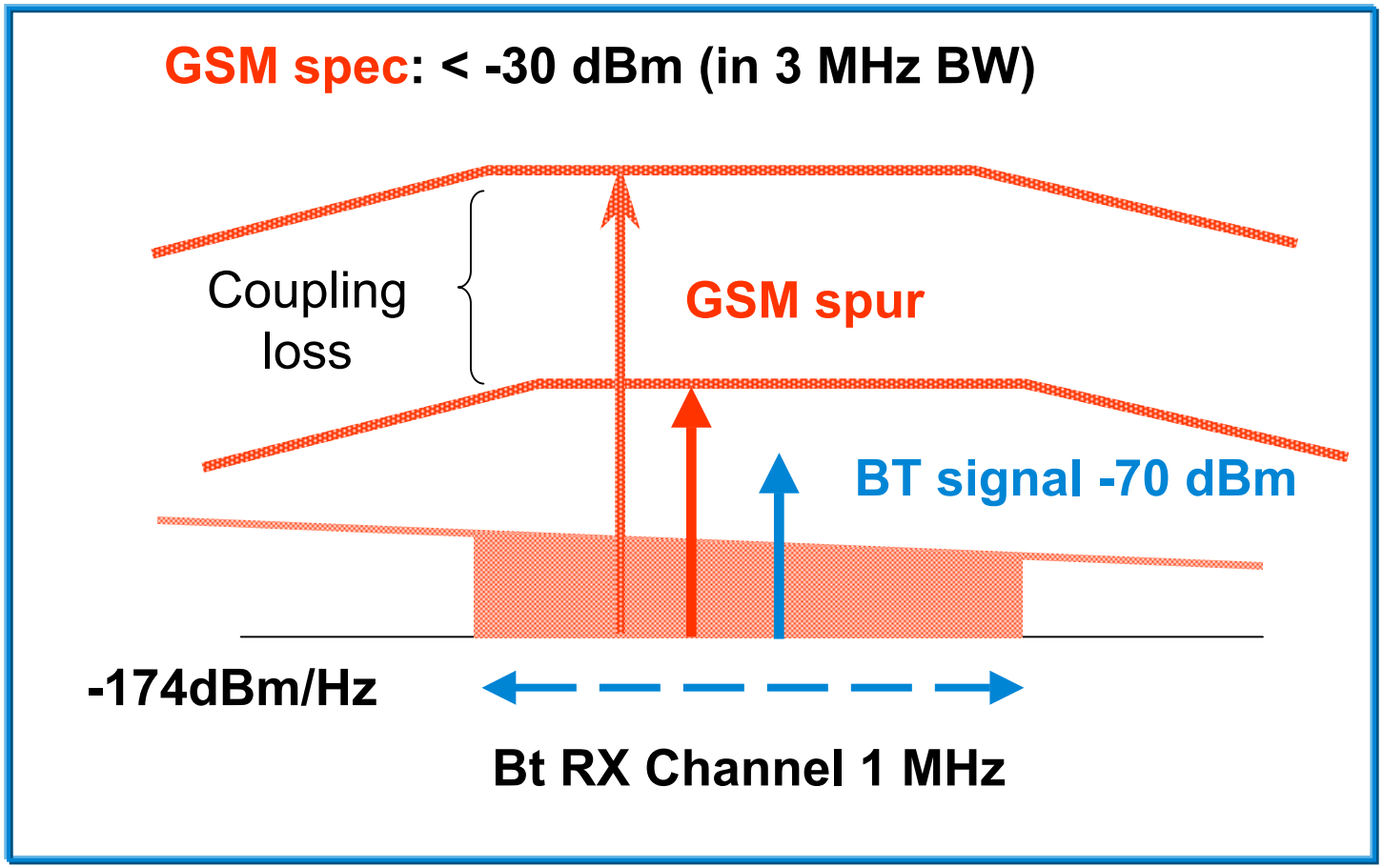
Spurious Desensitization – 2

GSM spurious can de-sense a Bluetooth receiver



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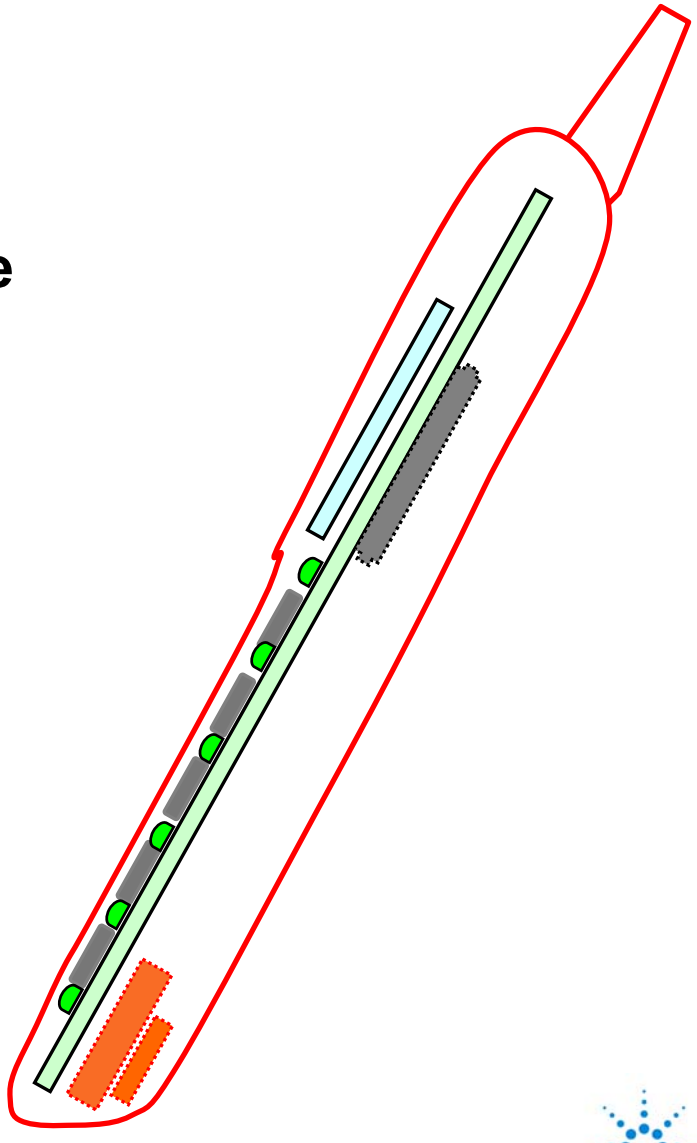
How do you get adequate isolation?

Maximize Distance between antennas



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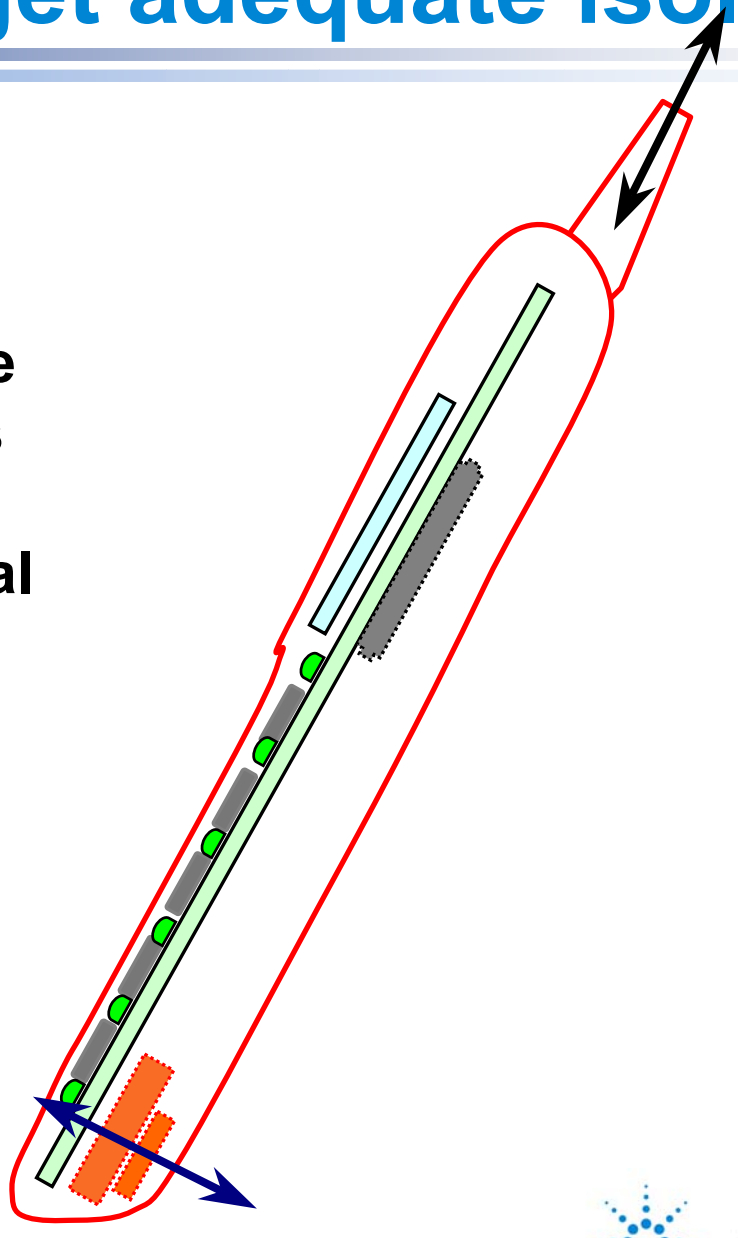
How do you get adequate isolation?

Maximize Distance between antennas

Choose orthogonal polarization



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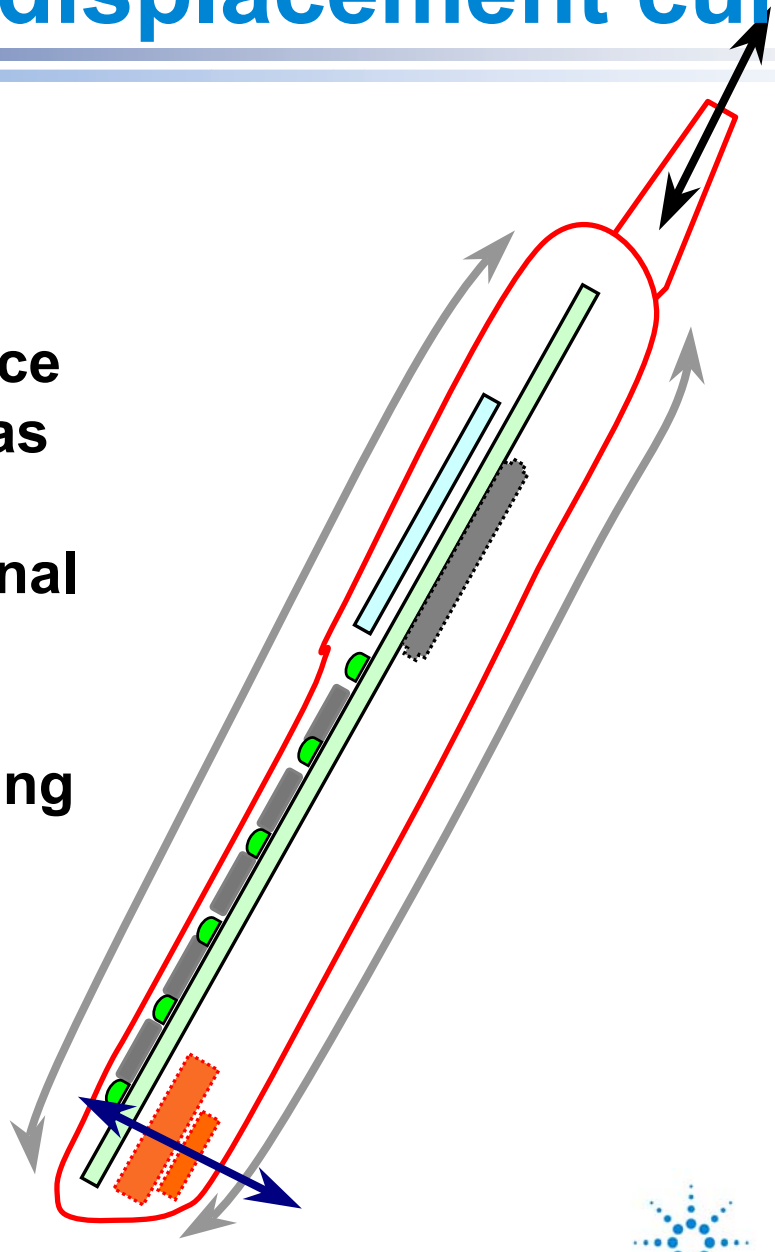
What about displacement current?

Maximize Distance between antennas

Choose orthogonal polarization

Consider Shielding and Grounding



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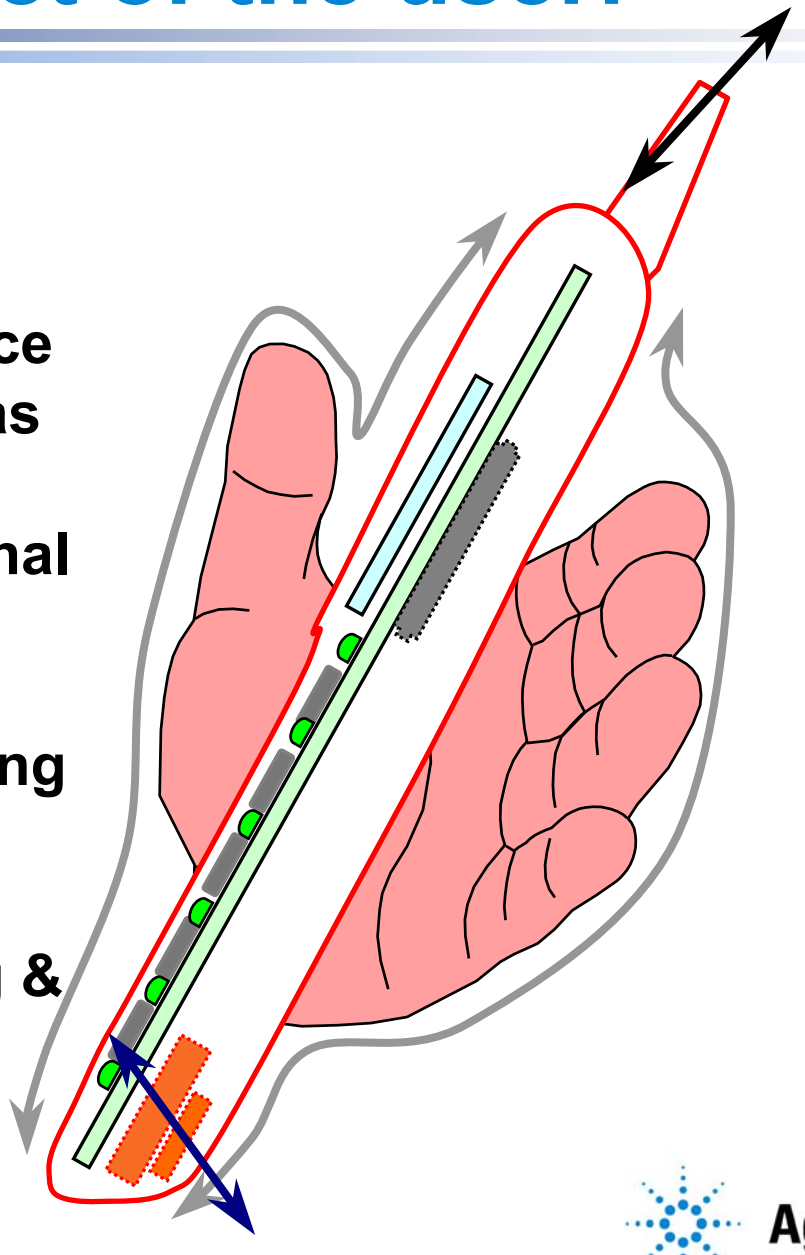
And the effect of the user!

Maximize Distance between antennas

Choose orthogonal polarization

Consider Shielding and Grounding

Optimize loading & match



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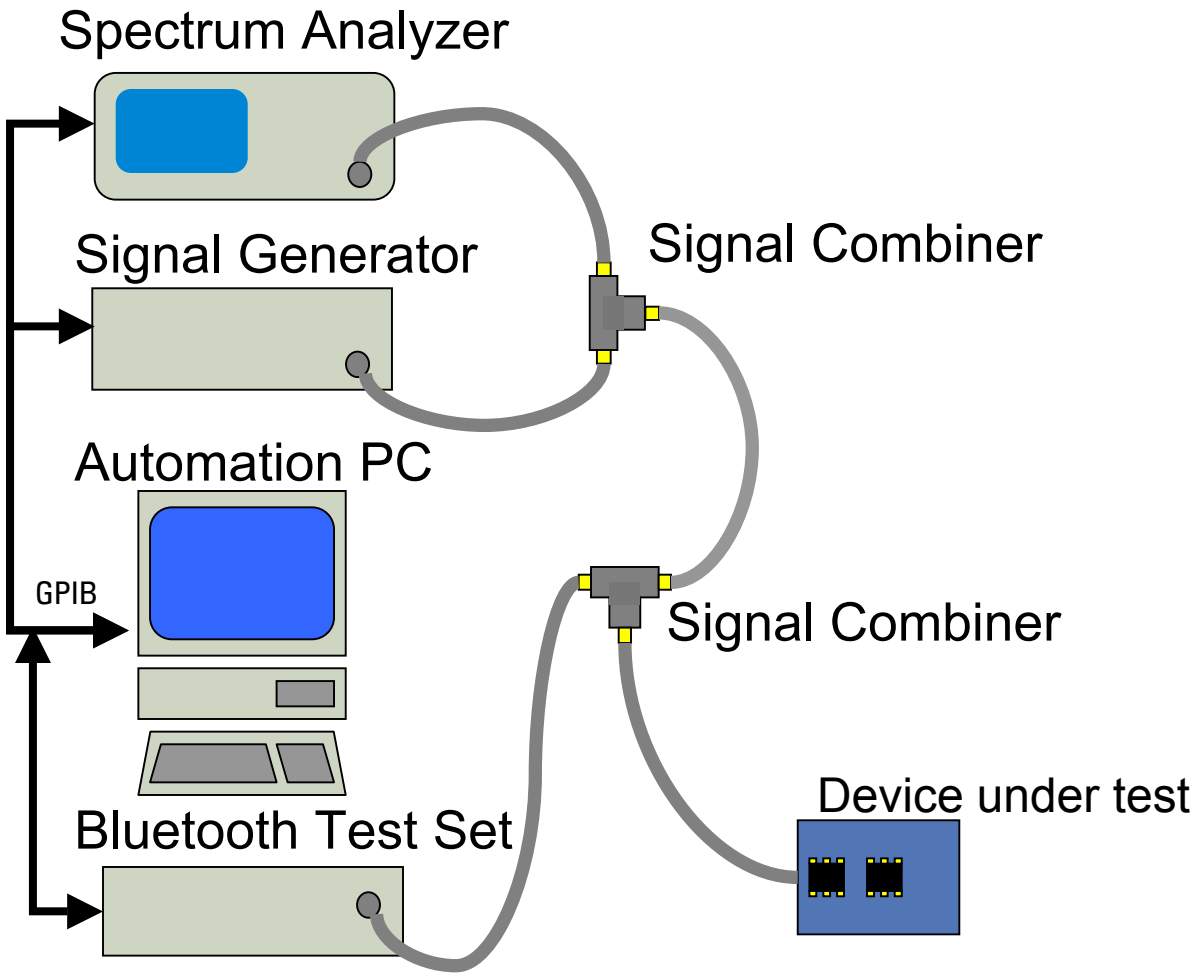
Test system - Out-of-channel test



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E1852B Integrated Test set

Information on the Agilent E1852B Bluetooth test set is available at

www.agilent.com/find/e1852B

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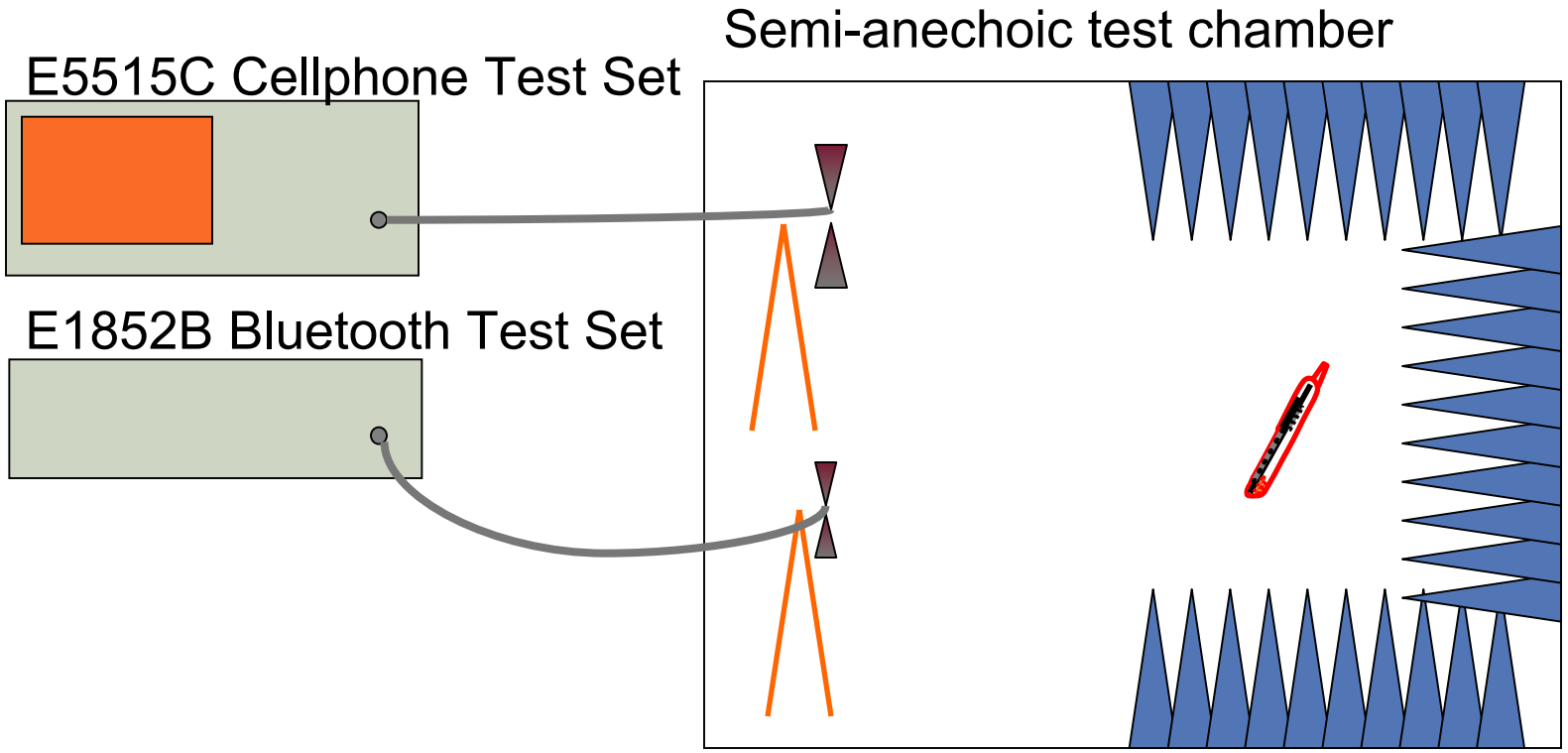
Radiated tests of GSM & Bluetooth



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GSM and Bluetooth co-existence

Production Considerations

- How do we best integrate test of cellular and Bluetooth functionality
  - Cost implications of test strategy
  - Simultaneous cellular/Bluetooth testing
  - Rework of failed/out-of-spec devices
  - Storage of calibration and identity data
  - Labeling

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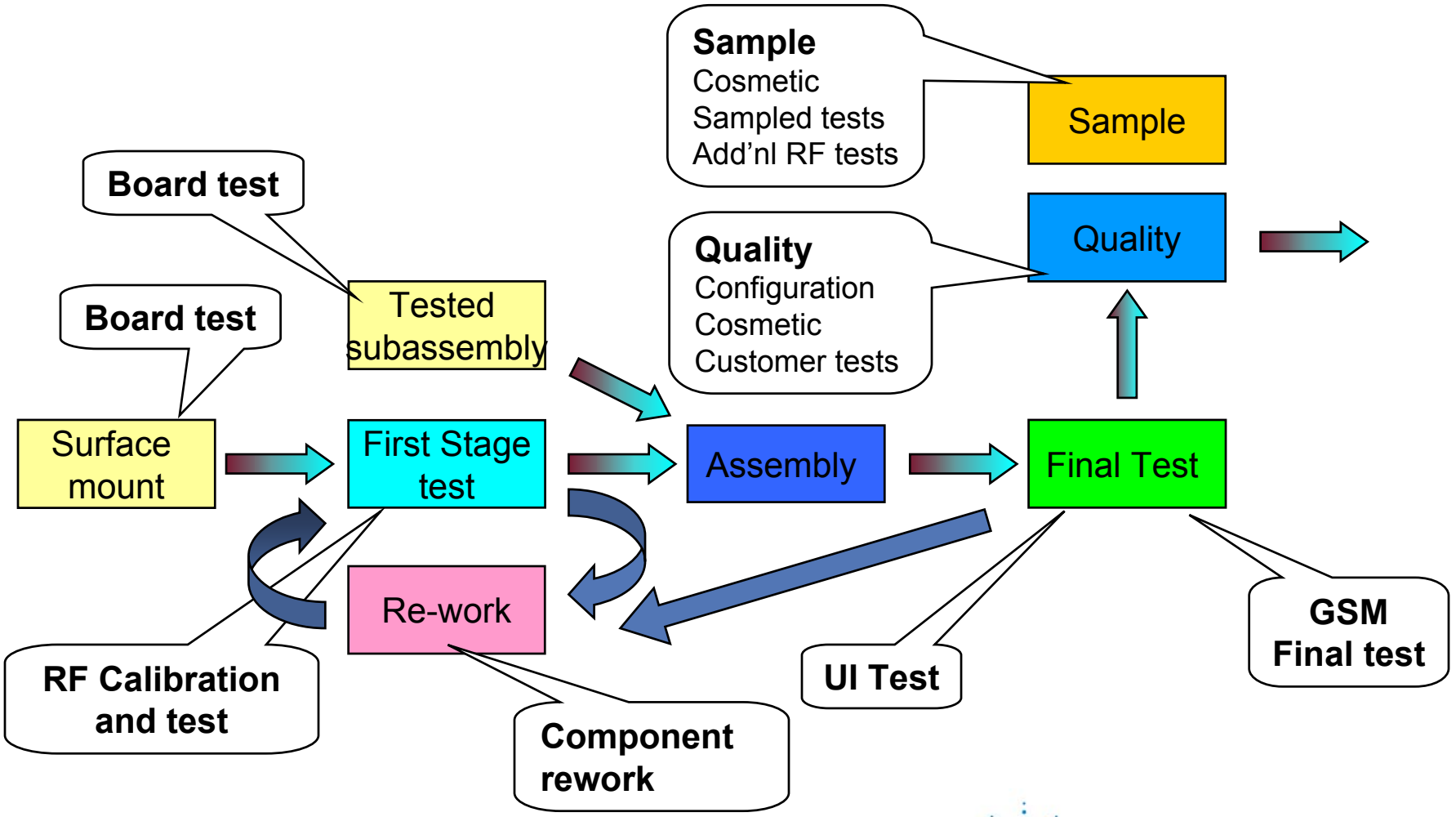
Handset manufacturing

Typical Test Process



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Handset manufacturing

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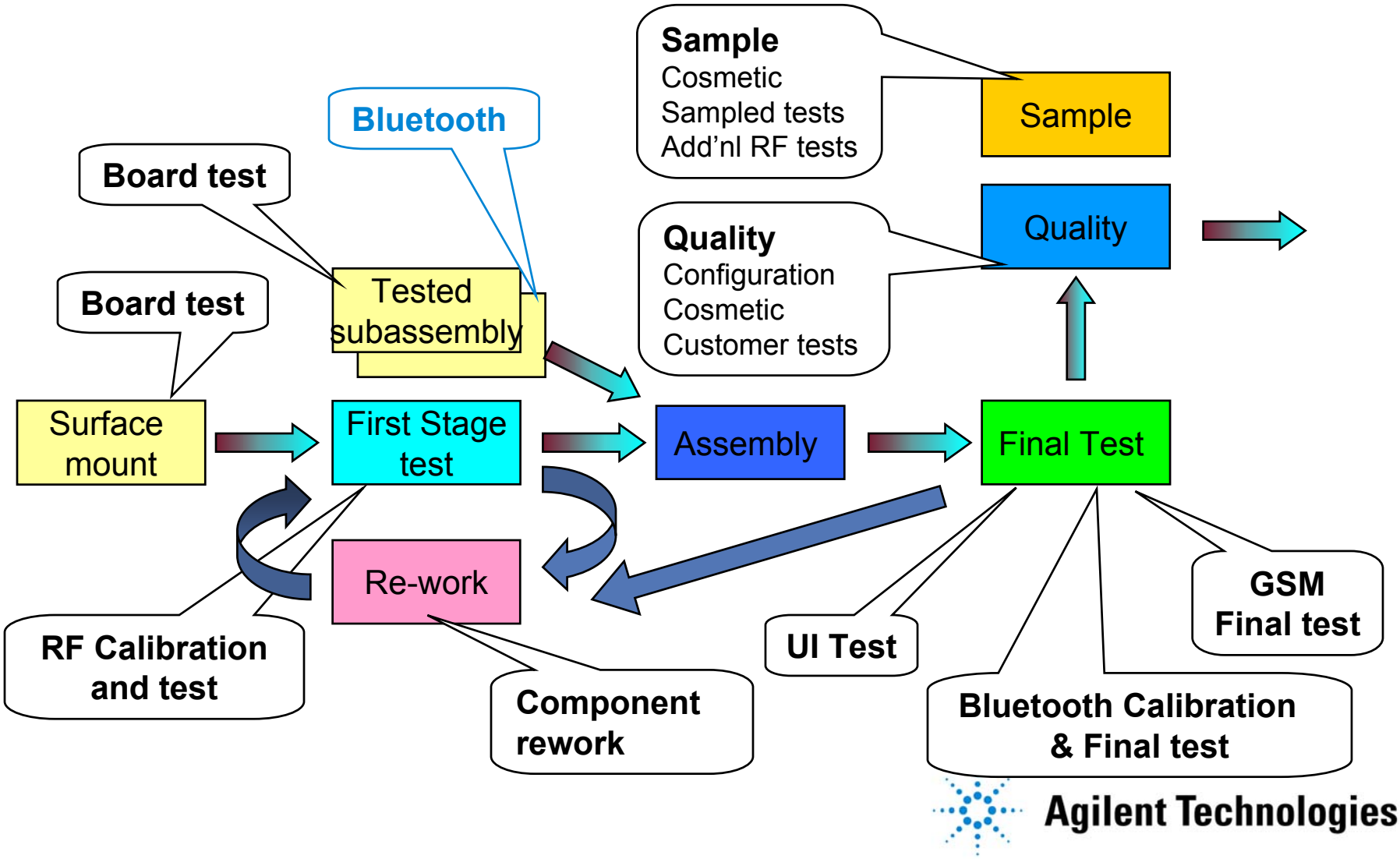

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Manufacturing tests

- Calibration
  - Adjustments performed to bring device into specification
- Parametric
  - Tests that measure performance or confirm adherence to specifications
- Functional
  - Check that device is ‘working’
- Programming
  - Test steps that store information into the device

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In Summary

- Integration of Bluetooth into a cellular handset can be accomplished with a straightforward series of steps.
- The basic standards do not describe how this can be achieved. Performance of the cellular and Bluetooth elements can be compromised
- Tests with the right equipment offer the opportunity to understand system performance as well as insight into issues that can cause trouble

Conclusion

- Ultimately any design needs to be manufactured so that it can be offered competitively in the marketplace.

  Carefully thought out test strategies will help you achieve this

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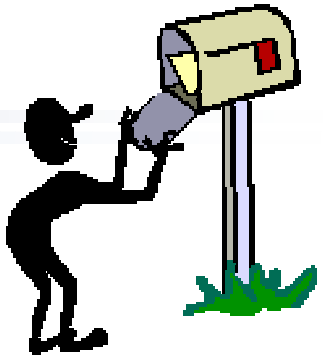

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