

Virtual Field Testing : A Global Approach for Cellular Communication Networks Test and Validation

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1. Introduction

As cellular communication systems are getting more and more sophisticated, and as time-to-market pressure shortens the global test effort for such systems, it becomes highly critical to introduce a novel testing and validation approach in order to make sure that the system will be properly tested before being launched on the market.

2. Virtual Field Testing (VFT) principles

The proposed approach consists in reproducing within the laboratory, test conditions that can only be achieved in the actual field as of today. In such an approach, the radio access network system is fully simulated, from the upper layer stacks (NBAP, RRC, GPRS) down to the lower stacks (RLC/MAC/Iub-FP/WCDMA). Also, the VFT platform contains a large number of radiating elements (MS, cells) to properly reflect interference conditions. VFT combines a large number of virtual elements surrounding few actual elements, some being tested.

Between each radiating element, VFT accurately simulates the propagation conditions (Near-Far, multipath, fading, birth/death, Doppler...), according to the respective position of the elements in the field and surrounding reflecting clusters. As input, the VFT tester uses outputs of radio planning tools (site position, propagation predicted maps, system parameters), as well as geo-marketing data (list of services to be offered, subscriber density per area, traffic profile per subscriber). In such approach, the test vector can be reduced to a set of mobility models (e.g. following predetermined trajectory, or based on a graph of streets) and traffic sessions to be provided in a given deployment area.

As a result, this approach can generate test conditions reflecting a typical usage of the equipment under test. Typical, for it models conditions of evolution of the radio channel, and the interference from other Cells/UE, in known areas of problems, exactly as in actual field tests.

3. Applications

This method can be applied for virtual drive tests, where drive test conditions are exactly reproduced within the lab to test mobile station individually, for the optimisation of handover parameters (e.g. timers, handover window, filtering method, reporting criterion and methods, ...).

The method can also be applied for testing Radio Resource Management (RRM) strategies and the associated claimed gains in capacity of the radio layer... It can indeed be applied for stress testing of BSS equipment (several hundreds of MS for Node B testing, several ten thousands of MS and hundreds of cells for RNC testing).

4. Associated Challenges

The implementation challenges for such an approach are the need for a large scalability of the radio modems and protocol stacks, the handling of the full complexity of the RAN, (as long as handover is involved), and the dealing

with a very large amount of propagation data in order to feed the tester in real-time with propagation parameters for multiple radio channels.

The recent introduction of powerful Software Radio Platforms [1] enables the joint implementation of Cells modems and propagation channels within one single reconfigurable hardware, based on a set of multiple DSPs and FPGAs. The propagation channels can get reconfigured with path information regularly computed by ray-tracing techniques, and achieves smart interpolation in between points to preserve fast fading behaviour.

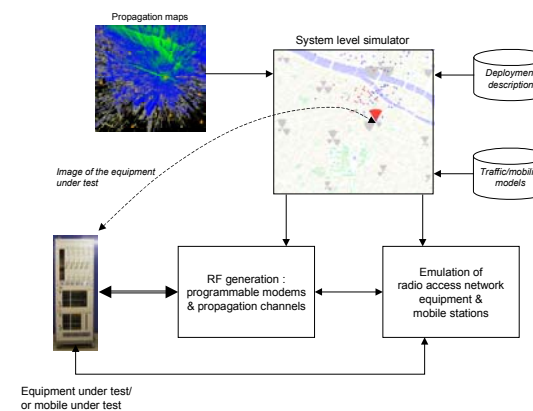


Figure 1: VFT platform overview

5. Benefits

This approach is expected to bring significant advantages compared to field tests. It can be used during the development process, much before actually deploying equipment on sites ; it can generate loaded situations, much before the market gets saturated, and at early stage when

MS are not necessarily available on the market for such tests ; it can reproduce field-test like situations also for investigating impacts of capacity optimisation techniques, consolidating the global business plan ; it also compare test results with results of reference implementations, and under exactly the same field test conditions.

In addition, such approach can generate a wide variety of probable situations from a limited number of understandable test parameters. The test complexity actually lies in the complexity of the propagation conditions which can not so easily be controlled in the actual field. Thanks to a good modelling of the complexity of the radio field, the VFT approach can automatically generate very complex and significant test cases.

6. References

[1] L. Luneau "FlexCell, Deployment and software views", SDR Forum, November 2002