Product Testing and Conformance: How standards can help

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Kurt B. Fischer, Physical Scientist
Public Safety Communications Research (PSCR)
www.pscr.gov

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Conformance Testing throughout Product Life Cycle

- After FCC grant, product changes are permitted: Class I, Class II, and Class III permissive changes.
- Test cases may never be repeated on the product.
- Product may undergo significant software, firmware, and silicon supplier changes (the developer may not be cognizant of some of these changes).
- Automatic conformance testing of air interface can be performed efficiently if automated test systems and product with a standard-based (not proprietary) Test Control Interface (TCI) are employed.

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Regulator and Developer Concerns

▸ How does the Regulator know if the product has been changed enough to effect DFS radar avoidance behavior without repeating all the test cases?

▸ How does the developer know if a product change has not effected the DFS radar avoidance behavior without repeating all the test cases?

▸ The lack of standard based behaviors leads to a scenario where an assumed insignificant product change could cause a severe interference problem.

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How could the Regulator and the Developer know that DFS algorithm conforms?

- Surveillance testing of all certified product for DFS algorithm conformance?
- Manufacturer data submitted periodically to Regulator and/or TCB?
- Wait for problems in the field?
- In the future perhaps a lack of standardization could become a reason for slowing DFS product operation and deployment in the UNII bands?

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Open Standards

Advantages

▸ Market Validation (developers promoting products for one standard).

▸ Testing Leverage possible.

▸ A standard host or Test Control Interface (TCI) possible.

▸ Interoperability can be maximized.

▸ Coexistence can be optimized.

Disadvantages

▸ Path to market may be slower due to standards development process.

▸ Originality and optimization of product design may be restricted.

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Closed or No Standards Approach

- Faster to market.
- Product design can be targeted to niche market.
- Product design and performance can be optimized.

- Interoperability between different developers is generally not possible.
- Coexistence is not optimized.
- Spectrum sharing is problematic.
- Difficult to integrate automatic test systems to cover all test cases.
- Test case development and execution are the responsibility of each developer (no leverage possibility).

Advantages

Disadvantages

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Dynamic Spectrum Access (DSA) Challenge

- DSA is a set of advanced technologies.
- The inefficiency and risk of not having a standard TCI for DFS product control and observation during conformance testing will be amplified with the complexity of DSA products.
- Without standard TCI, testing is slow (regardless of who does it) and conformance test case coverage for radio behaviors will be weak.
- Proposed solution: Use and develop DSA standards that conform with ISO/IEC 9646-x

Communications Standard Development Organization (SDO) Strategies

- ISO/IEC 9646-x based (also ITU-T x.290 series) standards based (e.g., 3GPP, LTE, BLUETOOTH Wireless Technology, WiMax)
- Hybrid standards that include some parts of ISO/IEC 9646-x standards (e.g. WiFi, IEEE 802.11, IEEE 802.15)
- Non ISO/IEC 9646-x standards based (remember IEEE 802.11 standard based products in late 1990s – both access point and client needed to be the same developer for interoperability)

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ISO/IEC 9646-x (also ITU-T X.290 series) standards for conformance test methodology

▸ Protocol Implementation Conformance Statement (PICS)
▸ Implementation Conformance Statement (ICS)
▸ Implementation eXtra Information for Testing (IXIT)
▸ Protocol Implementation eXtra Information for Testing (PIXIT)
▸ Conformance testing methodology
▸ Abstract Test Suite (ATS)
▸ Protocol Test Specifications
▸ Profile Test Specifications
▸ Tree and Tabular Combined Notation (TTCN)

If Product Test Control Interface (TCI) is included in the DSA standards then:

- Test and measurement equipment manufacturers and test system integrators may amortize development costs across a larger market base (potentially all product developers).
- Faster product development when testing is integrated into development rather than waiting until the product design is completed.
- Test specification and test cases versions can be identified with versions of test system software revision levels.
- New regulatory, protocol, or usage model / user profile test cases are usually just a test system software update.
- Development of a universal test system (for this communication standard) may be possible.
- In general test results are repeatable, commercially available, and viable for all products.

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Standardizing the behaviors not just the communication interface:

▸ Abstract simulation analysis and testing between the communication standard (SDL) and the test specification (TTCN) test vectors provide for validation of the both the standard and the test specification.

▸ Test vectors for allowed and prohibited behaviors.

▸ Conformance testing of air interface using extreme conditions (voltage, temperature, humidity, etc.) can be performed efficiently.

▸ Profiles restrict product behaviors and thus may promote interoperability and coexistence.

▸ DFS product behavior when subjected to radar simulation is standardized.

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Questions or Comments?

Kurt B. Fischer

Physical Scientist

Public Safety Communications Research (PSCR)

Office of Law Enforcement Standards (OLES)

National Institute of Science and Technology

United States Department of Commerce

phone: 301-975-6061

email: kurt.fischer@nist.gov

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Background Information

Extract of CFR Title 47, Rules and Regulations Concerning Product Changes

(emphasis was added by author and not in the original text)
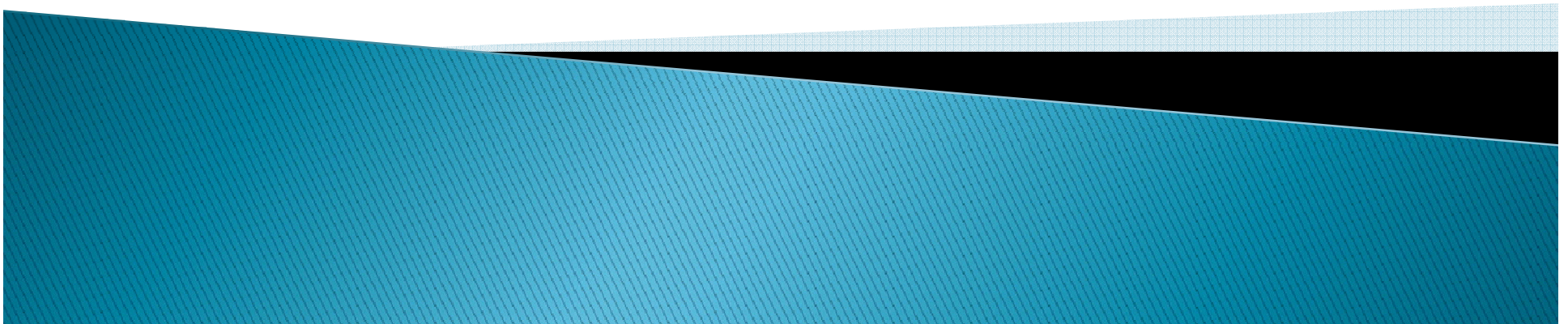
CFR Title 47 § 2.931, Responsibility of the grantee

- …the grantee warrants that each unit of equipment marketed … will conform to the unit that was measured and that the data (design and rated operational characteristics) filed with the application for certification continues to be representative of the equipment being produced … within the variation that can be expected due to quantity production and testing on a statistical basis.

CFR Title 47 § 2.932 (a), Modification of equipment

- (a) A new application for an equipment authorization shall be filed whenever there is a change in the design, circuitry or construction of an equipment or device for which an equipment authorization has been issued …

CFR Title 47 § 2.1043 (b), Changes in certificated equipment

- (1) A Class I permissive change includes those modifications in the equipment which do not degrade the characteristics reported by the manufacturer and accepted by the Commission when certification is granted. No filing with the Commission is required for a Class I permissive change.

- (2) A Class II permissive change includes those modifications which degrade the performance characteristics as reported to the Commission at the time of the initial certification. Such degraded performance must still meet the minimum requirements of the applicable rules. When a Class II permissive change is made by the grantee, the grantee shall supply the Commission with complete information and the results of tests of the characteristics affected by such change. The modified equipment shall not be marketed under the existing grant of certification prior to acknowledgement by the Commission that the change is acceptable.

- (3) A Class III permissive change includes modifications to the software of a software defined radio transmitter that change the frequency range, modulation type or maximum output power (either radiated or conducted) outside the parameters previously approved, or that change the circumstances under which the transmitter operates in accordance with Commission rules. When a Class III permissive change is made, the grantee shall supply the Commission with a description of the changes and test results showing that the equipment complies with the applicable rules with the new software loaded, including compliance with the applicable RF exposure requirements. The modified software shall not be loaded into the equipment, and the equipment shall not be marketed with the modified software under the existing grant of certification, prior to acknowledgement by the Commission that the change is acceptable. Class III changes are permitted only for equipment in which no Class II changes have been made from the originally approved device.

- Note to paragraph(b)(3): Any software change that degrades spurious and out-of-band emissions previously reported to the Commission at the time of initial certification would be considered a change in frequency or modulation and would require a Class III permissive change or new equipment authorization application. (4) Class I and Class II permissive changes may only be made by the holder of the grant …