

Modular Waveform Design for Reuse and Incremental Evolution

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Agenda

- Scope of the Presentation
- Key Success Factors for a Portable Waveform Design
- Porting Experiences
 - Legacy Waveforms
 - Networking Waveforms
- Lessons Learned

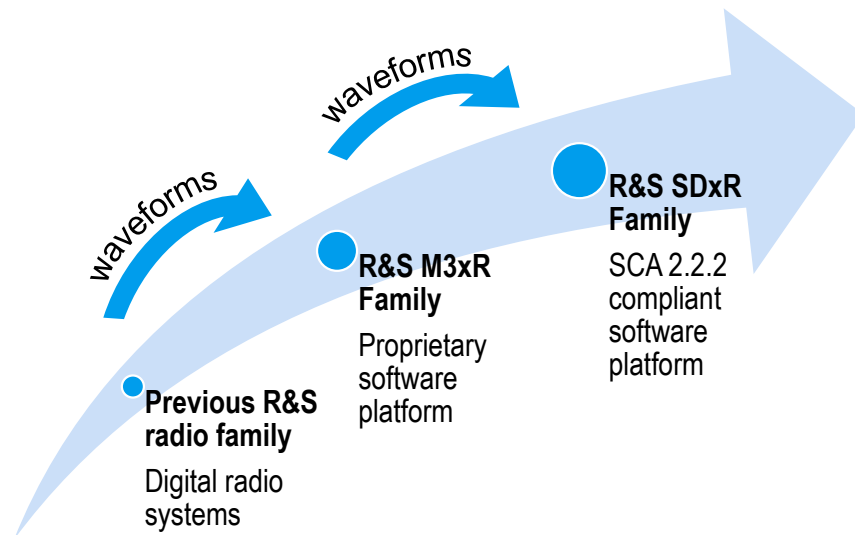


Scope of the Presentation

Scope

Porting has always been an issue

- New systems are required to support:
 - Established “legacy” waveforms
 - New waveforms for joint and combined operations
- This presentation highlights selected waveform porting experiences between:
 - Different radio families
 - Different form-factors of a family



Considered Radio Platforms

Market segment	Non-SCA platforms	SCA 2.2.2 platforms
<p>Army</p> 	 <p>R&S® M3TR</p>  <p>R&S® MR3000P</p>	 <p>R&S® SDTR</p>  <p>R&S® SVFuA</p>
<p>Navy</p> 	 <p>R&S® M3SR 4100</p>  <p>R&S® M3SR 4400</p>	
<p>ATC/AD</p> 	 <p>R&S® Series 4200</p>  <p>R&S® M3SR 4400</p>	
<p>Avionics</p> 	 <p>R&S® M3AR MR6000L</p>  <p>R&S® M3AR MR6000A</p>	 <p>R&S® SDAR</p>

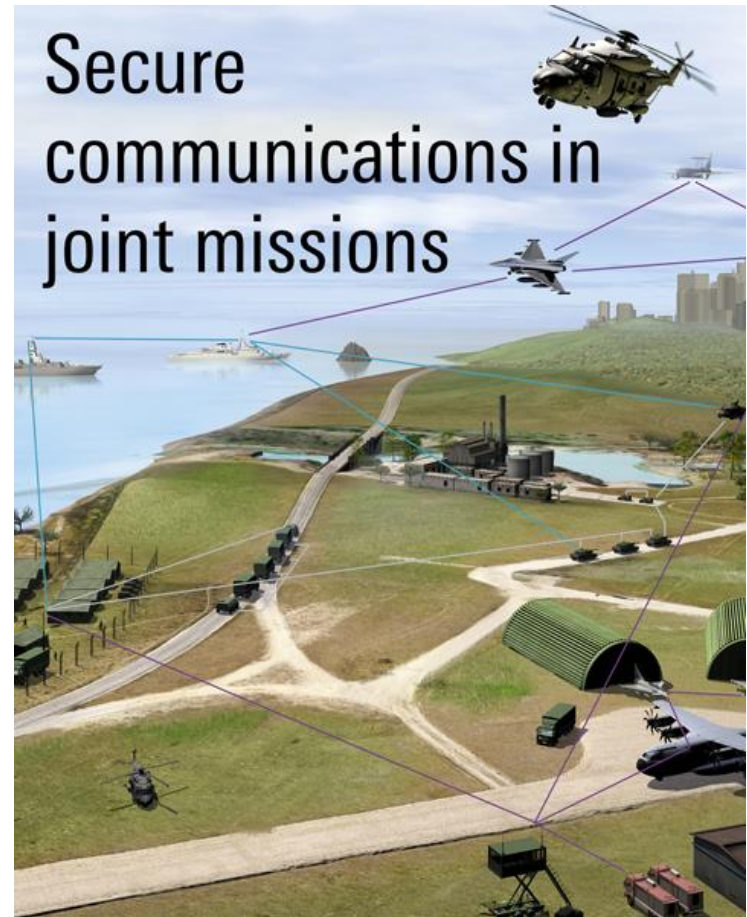
Considered Waveforms Applications

I Legacy Waveforms

- NATO Fixed Frequency
- NATO Have Quick
- SECOM Family
- SECOS Family

I Networking Waveforms

- High Data Rate Family

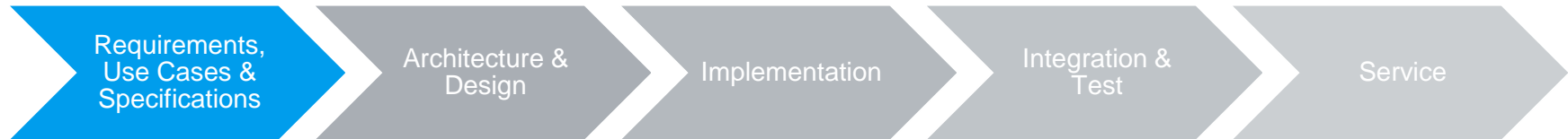


What are the key success factors for a portable waveform design?

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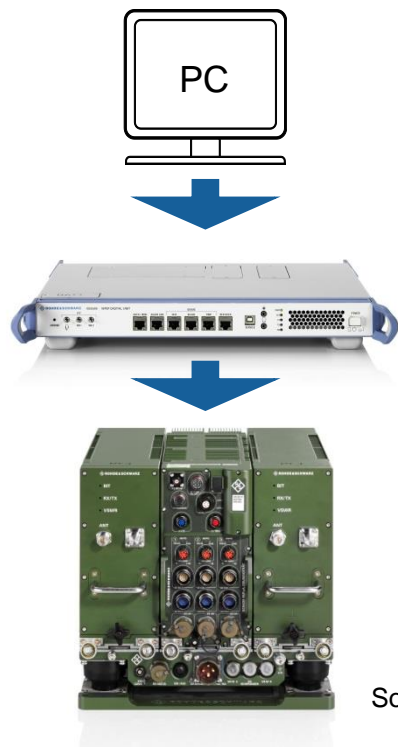
Overview

- Standardized processes and tooling covering the complete lifecycle
- Standardized waveform development and porting approach
- Standardized separation between waveform and radio platform
- Standardized architecture framework for waveforms
- Standardized approach to safety and security



What are the key success factors for a portable waveform design?

Standardized waveform development and porting approach



Source: Fraunhofer

■ Waveform Simulation Platform

- Verification of the waveform model
- Checking the data flow

■ Waveform Development Platform

- Testing the real time performance
- Real-time debugging
- Access to transceiver module
- Integration and regression testing

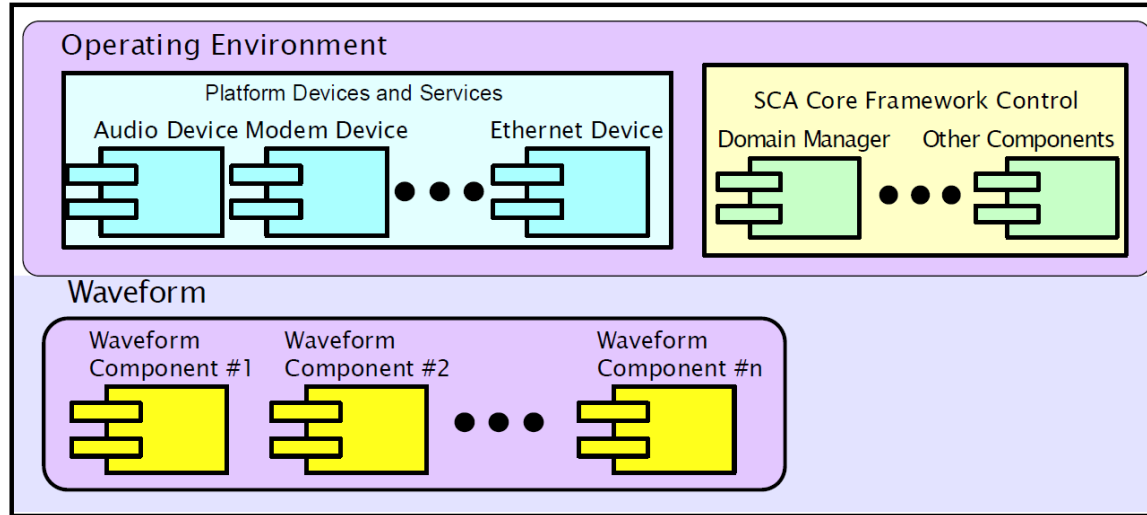
■ Target platforms

- Security features (encryption etc.)
- Multiple lines (relay, gateway, etc.)
- Integration and regression testing

What are the key success factors for a portable waveform design?

Standardized separation between waveform and radio platform

- Standardized architecture of the radio system
- Strict separation between radio platform and waveform application
- Standardized access to radio devices and services

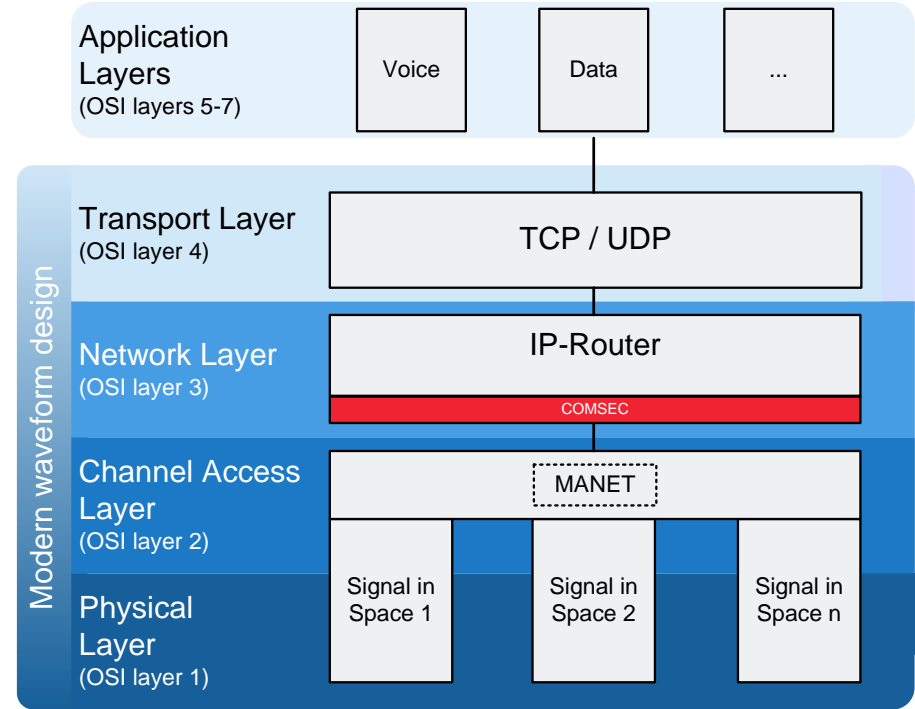


Source: SCA specification 4.1

What are the key success factors for a portable waveform design?

Standardized architecture framework for secure waveforms

- Adequate modularization of the waveform functionality
- Standardized APIs between the functional components
- Waveform library with reusable components

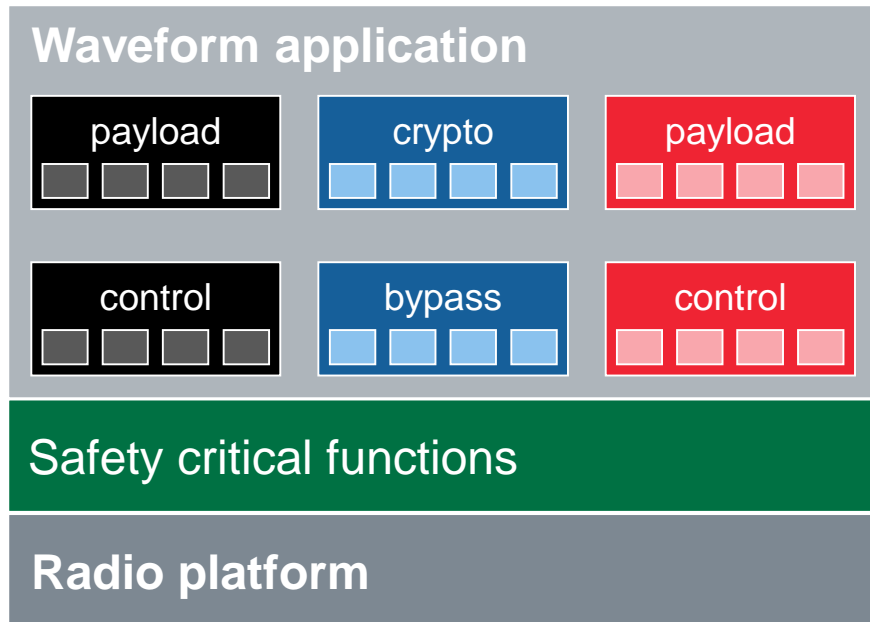


ISO/OSI view

What are the key success factors for a portable waveform design?

Standardized approach to safety and security

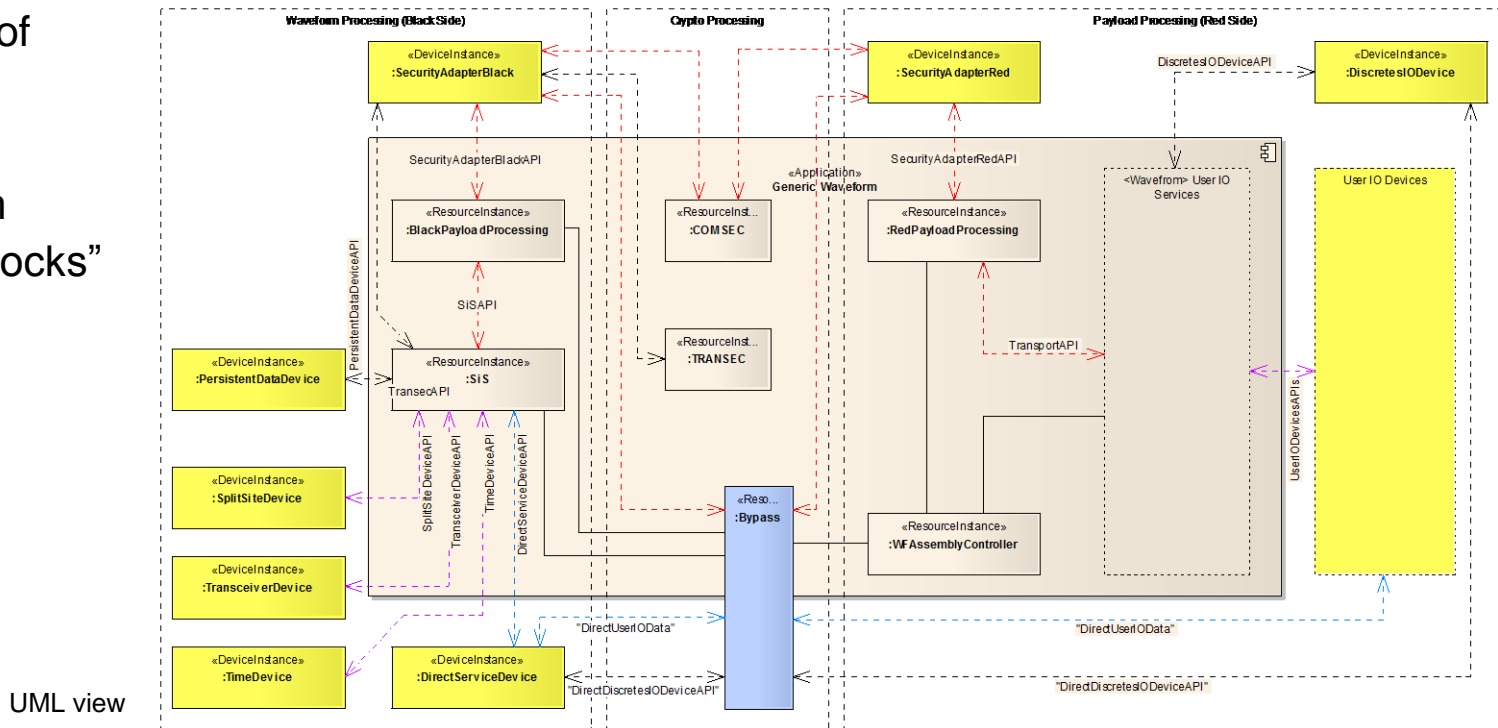
- Architecture Framework supporting red/black and payload/control separation
- Standardized approach for achieving compliance to safety regulations



What are the key success factors for a portable waveform design?

Standardized architecture framework for secure waveforms

- Provision of template functional “waveform building blocks”



Legacy Waveforms: Porting Experiences

NATO Fixed Frequency waveforms

Porting approach

■ Characteristics of the non-SCA source platform

- The core functionality of the waveform is deployed on DSP (“signal-in-space”)
- Higher layers and supporting functionality are deployed on GPP and DSP

■ Approach to porting

- A new MDA-driven toolchain was used
- The functional blocks of the “signal-in-space” were encapsulated in plain classes
- The plain classes were embedded into actor classes which provide the standardized interfaces, communication means as well as all other environmental and glue logic to enable the plain classes to perform the core functionality



NATO Fixed Frequency waveforms

Porting approach

■ Approach to porting – continued

- The DSP software remains on a DSP
- The operating system of the DSP was used as middleware on both platforms
- The interfaces of the DSP to the other processing nodes were newly developed
- The supporting artifacts were newly developed



NATO Fixed Frequency waveforms

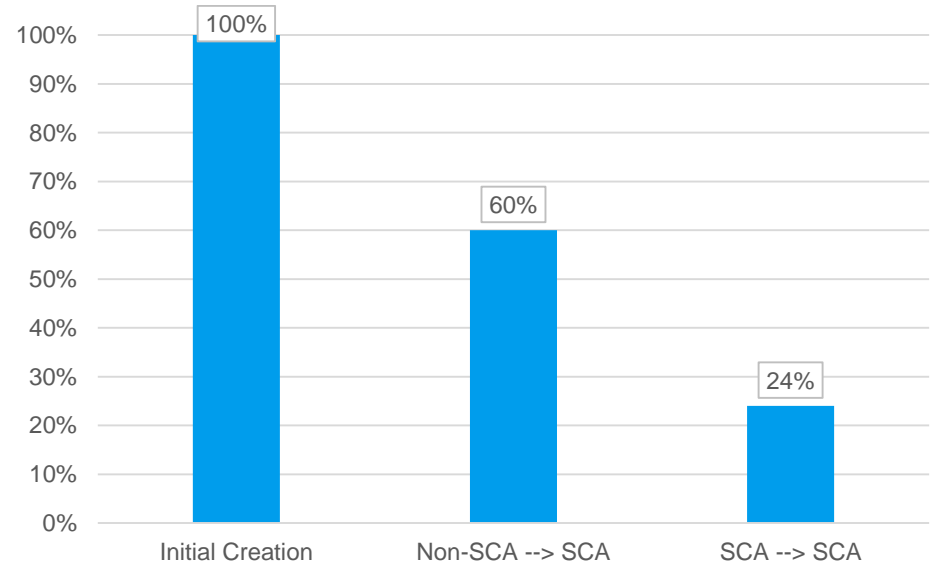
Code reuse and porting costs

■ Code reuse

- 60% of the DSP code of the non-SCA platform were reused

■ Relative porting costs w/o specification

- See diagram



Frequency agile waveforms

Porting approach

■ Characteristics of the non-SCA source platform

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Frequency agile waveforms

Porting approach

■ Approach to porting – continued

- The GPP software was ported from the GPP to a DSP-core
- The operating system of the DSP was used as middleware
- The interfaces of the DSP to the other processing nodes were newly developed
- The supporting artifacts were newly developed
- New design elements for red/black separation were introduced
- The MDA approach proved extremely beneficial for porting SCA compliant functional blocks between different types of processing nodes (GPP, DSP)



Frequency agile waveforms

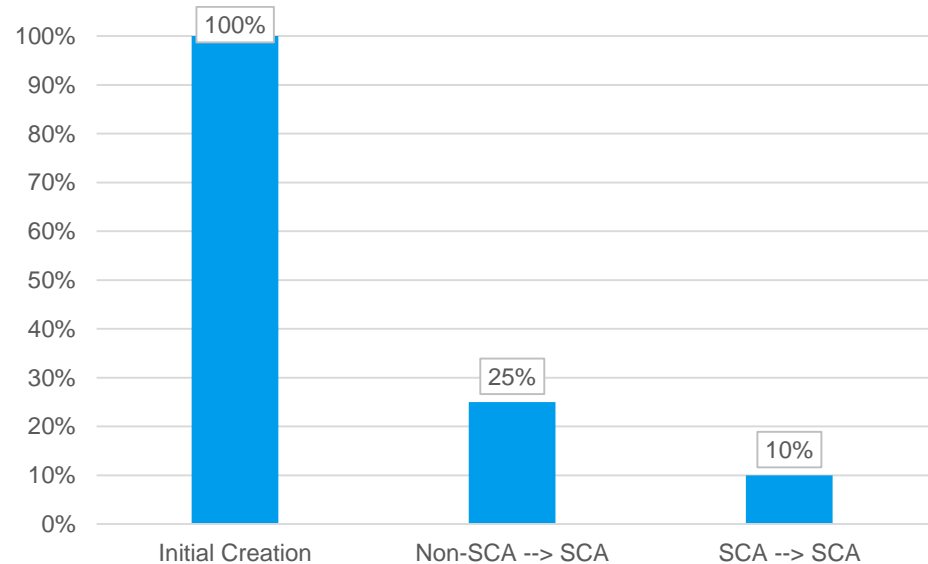
Code reuse and porting costs

I Code reuse

- 25% of the code from the non-SCA platform could be reused
- Instead code of other waveform implementations was reused
- The DSP software had to be newly developed

I Relative porting costs w/o specification

- See diagram



Lessons Learned

Porting from a non-SCA radio platform to an SCA compliant one

1. Do not develop your tool chain and your product in parallel
2. Using the same tooling for the different environments from the PC Simulation to the tests on the final target platform improves the depth and width of testing
3. Using an MDA-approach allows to easily move actors between different types of processing nodes
4. A sound software architecture is essential



Networking Waveforms: Porting Experiences

Networking Waveform

Development approach

I A green-state-approach to the SCA-platform was taken

- All parts of the waveform were developed from scratch
- Key requirements defining the architecture were:
 - SCA compliance
 - Security requirements

I The evolution was non-linear

- The initial waveform components were developed in a rapid prototyping approach
- These components were later replaced by refined solutions
- During this process the hardware platform evolved
- Many of the waveform components are shared between the members of the waveform family

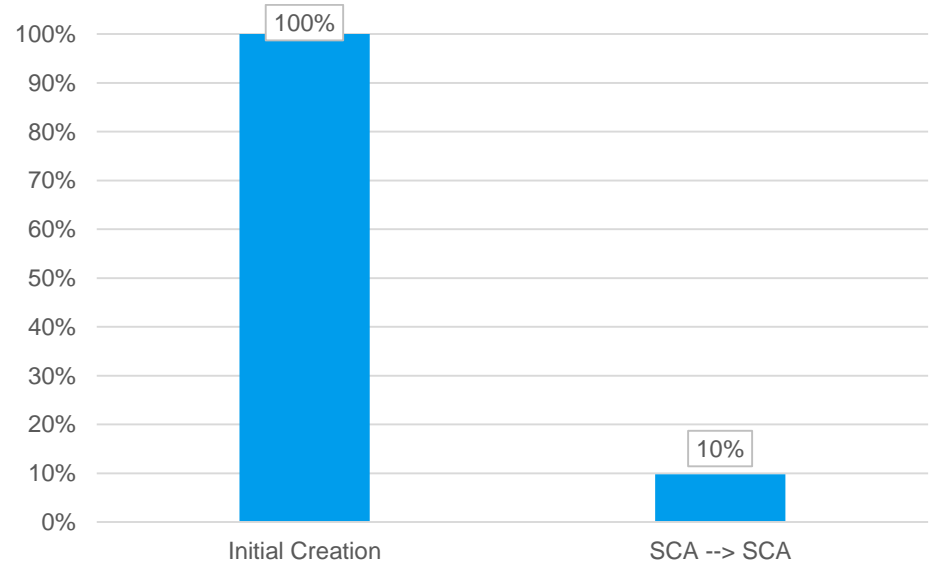


Networking Waveform

Porting costs

■ Relative porting costs w/o specification

- For all members of the networking waveforms the relative porting cost were quite similar
- The diagram displays a summary view



Lessons Learned

Porting between SCA compliant radio platforms

1. The capabilities of SCA devices can differ
2. Awareness of interface definitions (Are the same structures and types used?)
3. The dynamic behaviour of the platform can differ (e.g. start-up, characteristics of internal communication channels, real-time behaviour)
4. Component deployment can differ
5. Characteristics of processing nodes can differ (64bit or 32bit, endianness, compiler settings for basic type definitions)



Summary

Rules we follow to achieve a modular waveform design

1. Respect the platform/waveform separation: One task at one place and do not duplicate tasks
2. Divide and conquer: Keep information and processing cores for one function together
3. Respect the red/black boundary: Classify the data and the processing cores
4. Define APIs precisely, make them generic and useful
5. Also think system, network and radio level



Never forget to think system!

System level

Lifecycle & process

Networking & security

Management & configuration

ILS

Radio level

Waveform architecture framework

Waveform/platform separation

Safety & security

Tooling

Module level

Technology

Interfaces

Hardware & RF performance capabilities



Thank you



Now its time for questions and comments

