ACQUIRING NATIONAL SOVEREIGNTY IN COMMUNICATIONS USING SOFTWARE DEFINED RADIO

AN INDUSTRIAL PERSPECTIVE

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WHY SOVEREIGNTY IN COMMUNICATIONS?

- In the Information Age, communications are one of the most valuable assets.
- All modern countries desire to be sovereign (i.e. independent) in their communications.
- Sovereignty Factors:

> **Keeping control over communications is essential in the Information Age. The three key elements to achieve this control are: Knowledge, Confidence and Adaptability.”**

TRADITIONAL COMMUNICATIONS SCENARIO

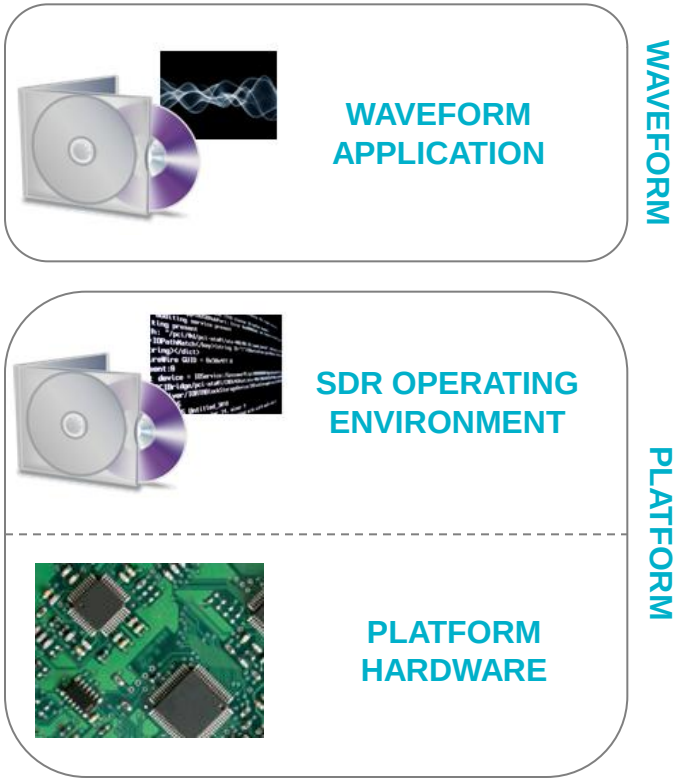
- Sovereignty in communications using legacy equipment requires physical control of the terminal hardware.

- Communication capability is associated to the hardware.
- *Knowledge* and *Confidence* rely on the hardware equipment.
- *Adaptability* usually requires changes / upgrades to the hardware equipment.
- Communications capabilities are usually offered by a (single) national provider.

> **The control over communication has traditionally required the physical control of the terminal hardware, with the resulting dependency and lack of flexibility”**

SOFTWARE DEFINED RADIO
A PARADIGM SHIFT IN COMMUNICATIONS

> **Radio communication system where some or all the *physical layer* functions (according to OSI reference model) are implemented in software"[1]**



- **WF Application**
  - *SW implementing the communications protocol.*
- **SDR Operating Environment**
  - *Operating System*
  - *Communication Middleware*
  - *Architectural Framework (e.g. ESSOR architecture , SCA, …)*
- **Hardware**
  - *RF Analog Subsystem*
  - *BB Digital Subsystem*

(1) Wireless Innovation Forum & IEEE

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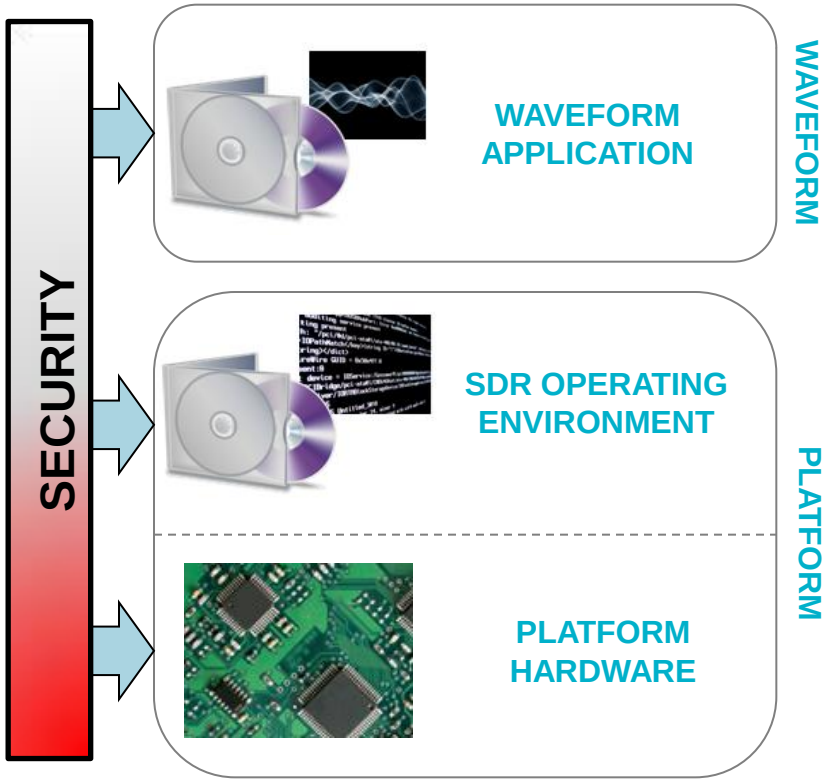
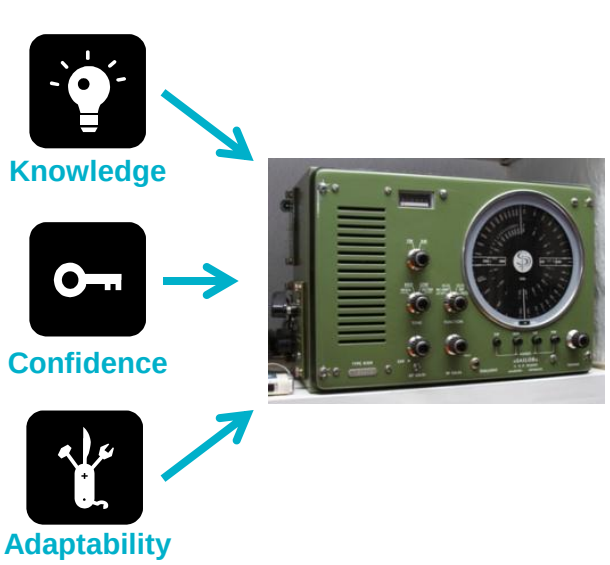


- **WF Application**
  - *SW implementing the communications protocol.*
  - ***IA capabilities (COMSEC/NETSEC/TRANSEC)***
- **SDR Operating Environment**
  - *Operating System*
  - *Communication Middleware*
  - *Architectural Framework (e.g. ESSOR architecture , SCA, …)*
  - ***Radio Security Services (RSS)***
- **Hardware**
  - *RF Analog Subsystem*
  - *BB Digital Subsystem*
  - ***CS/S Subsystem***

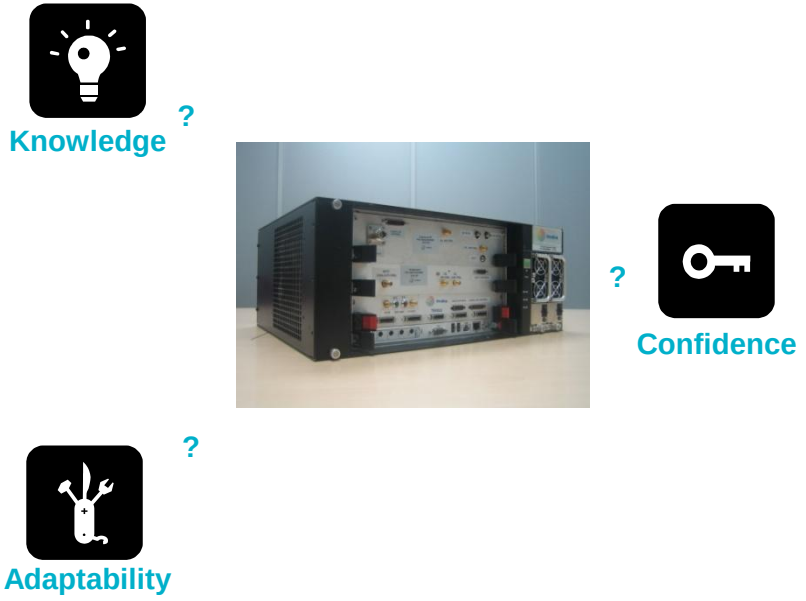
ALLOCATION OF SOVEREIGNTY FACTORS

LEGACY EQUIPMENT



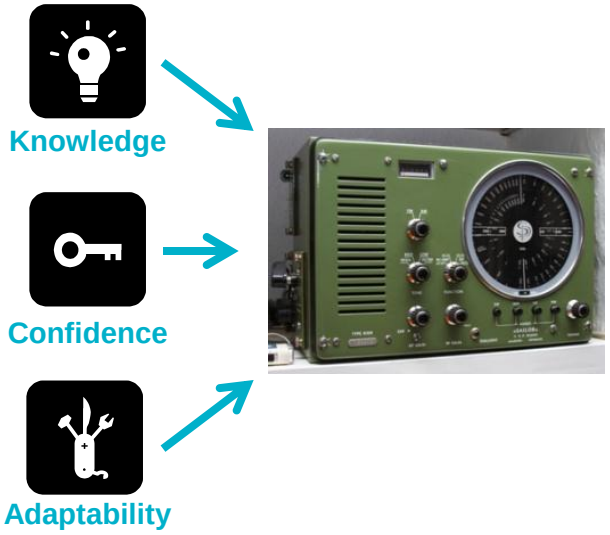
→ Direct Allocation

SDR EQUIPMENT



ALLOCATION OF SOVEREIGNTY FACTORS (II)

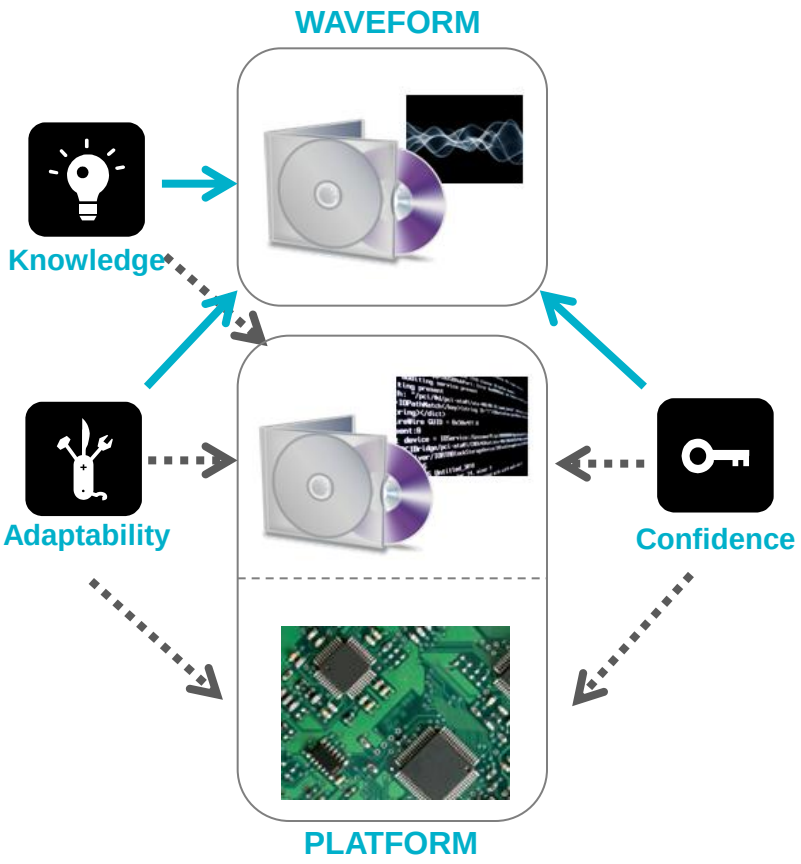
LEGACY EQUIPMENT



Direct Allocation

Indirect Allocation

SDR EQUIPMENT



SDR COMMUNICATIONS SCENARIO

- Sovereignty in communications using Software Defined Radio can be thought as controlling the WF application… but

- *Confidence* is provided by the security mechanisms of the Waveform application… *but it depends on the platform security capabilities.*
- *Adaptability* is granted by the software nature of the Waveform ***application****… but it depends on the platform performance.*
- Sovereignty over communications is granted by controlling the Waveform application… *only if the platform provides appropriate support.*

> **Software Defined Radio presents additional challenges for the acquisition of sovereignty in communications, requiring the control of Waveform and Platform”**

TRADITIONAL SCENARIO VS SDR SCENARIO

LEGACY EQUIPMENT

- Communications using legacy equipment require having control of the terminal hardware in order to provide sovereignty in communications.

SDR EQUIPMENT

- Communications using SDR equipment require having control of the Waveform application and the Platform in order to provide sovereignty in communications.

TRADITIONAL SCENARIO VS SDR SCENARIO

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TRADITIONAL SCENARIO VS SDR SCENARIO

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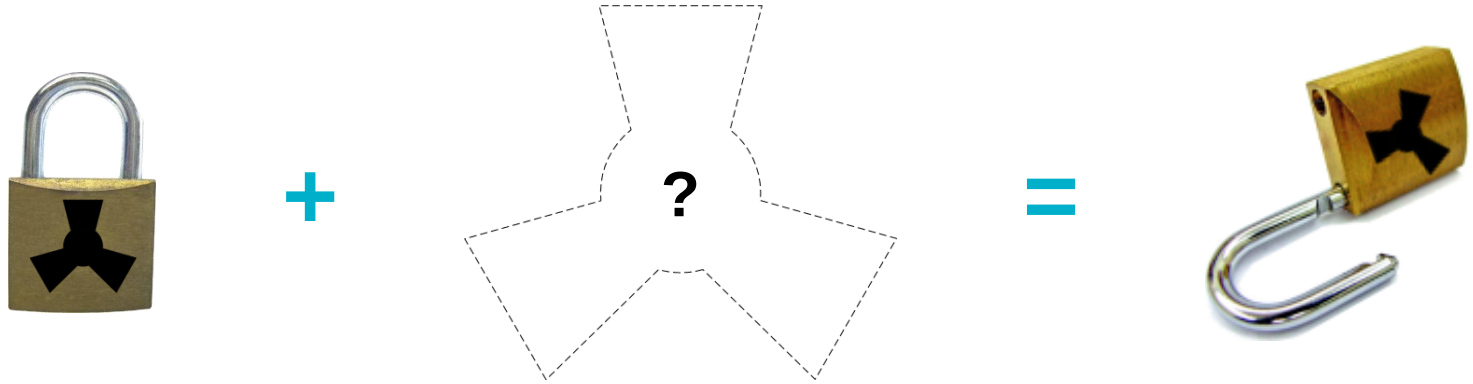
SDR EQUIPMENT

- Communications using SDR equipment require having control of the Waveform application and the Platform in order to provide sovereignty in communications.

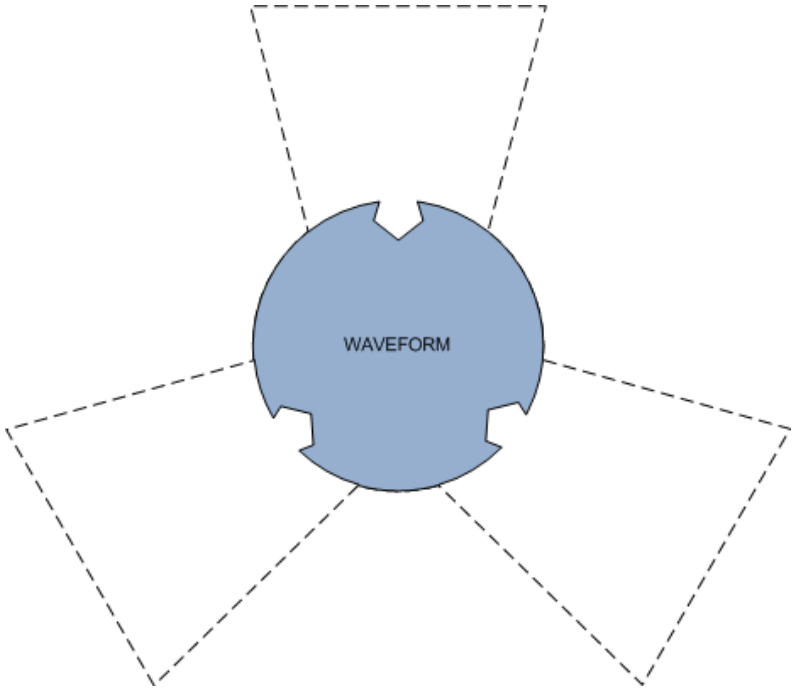
KEY CONTROL ELEMENTS: DEFINITION

- Components in an SDR system that have to be identified, evaluated and controlled in order to guarantee independency in the communications.



KEY CONTROL ELEMENT: WAVEFORM

- Main element providing the communication capability



Things to avoid

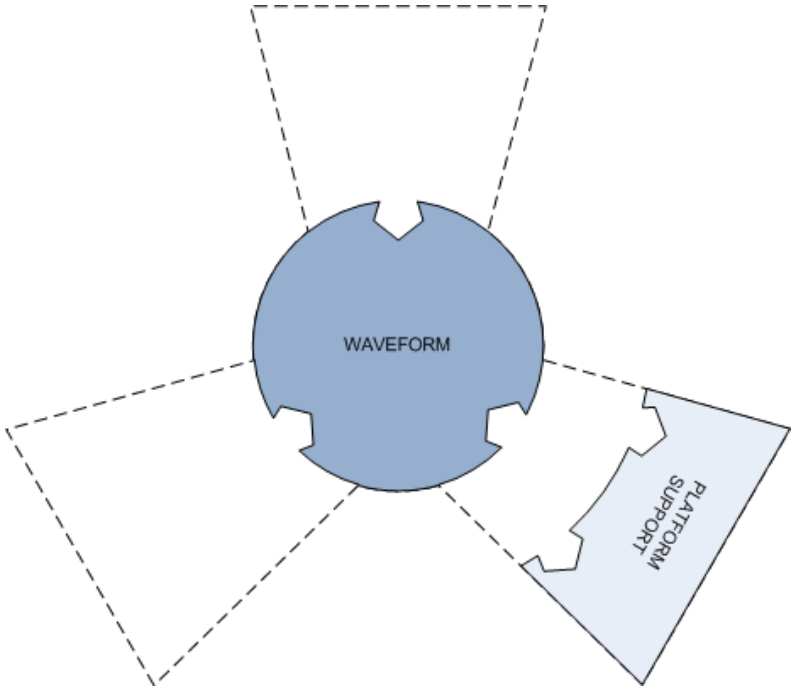
- Unspecified behavior
- Security vulnerabilities
- Interoperability issues

Things to consider

- Complete specification
- Golden reference available
- Simulation
- Interoperability tests definition
- Performance characterization
- Security functionality clearly specified

KEY CONTROL ELEMENT: PLATFORM SUPPORT

- Element driving the performance and overall capabilities of the radio equipment



Things to avoid

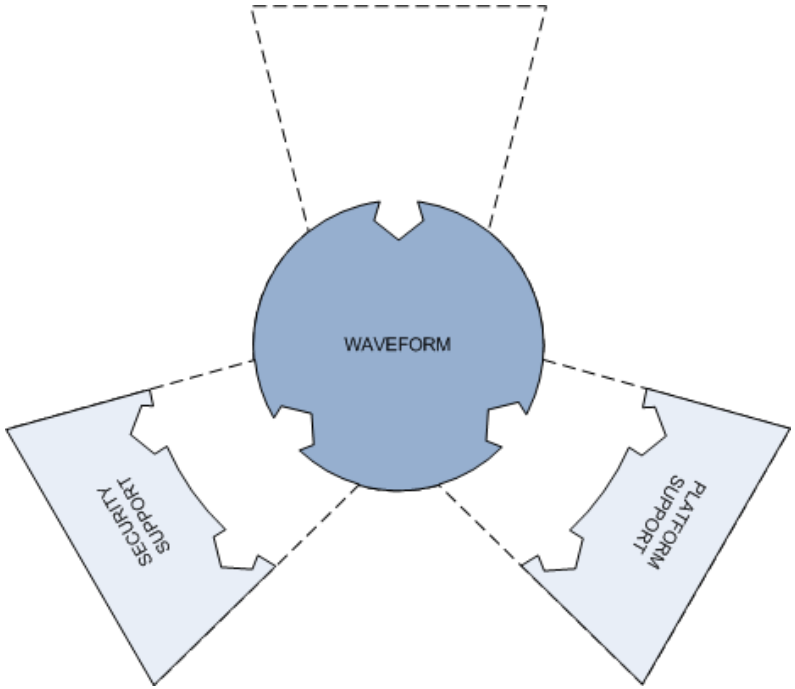
- Performance limitations
- Functionality limitations
- Lack of customization

Things to consider

- HW architecture
- Digital processing capabilities
- RF performance
- Real-time capabilities
- Middleware performance figures
- Framework provided (ESSOR, SCA)
- Implemented Services (APIs)

KEY CONTROL ELEMENT: SECURITY SUPPORT

- Element driving the security capabilities of the radio equipment



Things to avoid

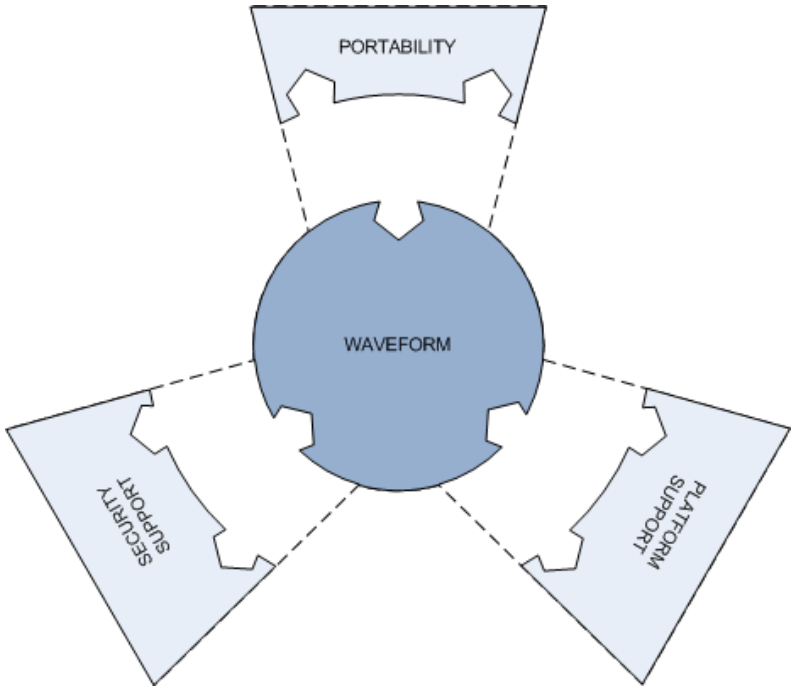
- Performance limitations
- Functionality limitations
- Lack of customization
- Lack of visibility

Things to consider

- CS/S architecture
- CS/S Programmability
- CS/S performance
- Logical architecture (e.g. data/control plane separation)
- Anti-Tamper mechanisms
- Supported crypto-engines
- MILS support capability
- Implemented Services (APIs)

KEY CONTROL ELEMENT: PORTABILITY

- Element guarantying the independency of the communications from the radio equipment



Things to avoid

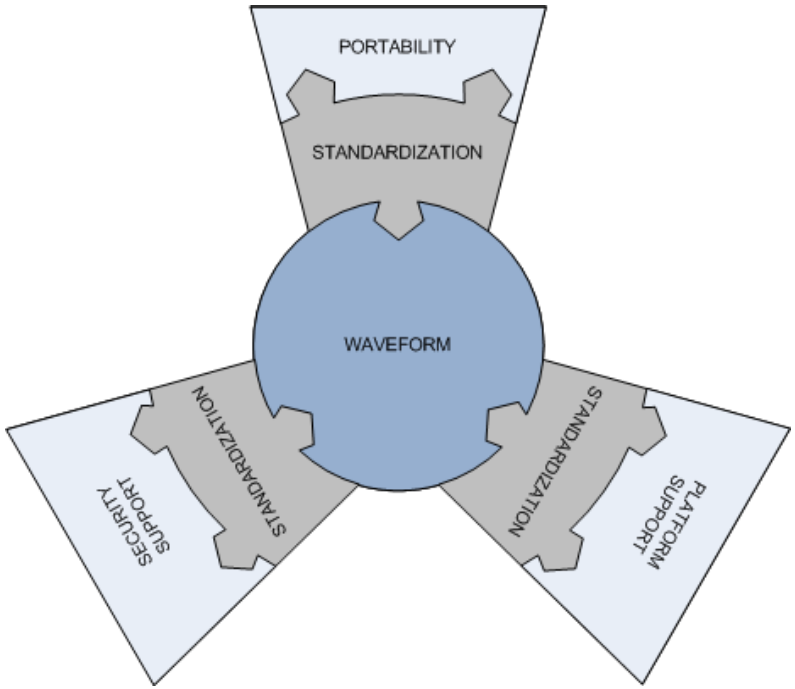
- Missing or incomplete software design documentation
- Target coupled designs

Things to consider

- Usage of architectural frameworks (e.g. ESSOR)
- Limit usage of API extensions
- Use extended standard languages (C/C++, VHDL, …)
- Avoid Target languages extensions
- Follow best practices (currently missing standard rules)
- Definition of a target agnostic baseline (i.e: ESSOR Base WF approach)

KEY CONTROL ELEMENT: STANDARDIZATION

- Global element that control the interactions among the rest of the elements



Platform Support

- Existing standards defining the functional capabilities of the platform (Devices and Services) and providing mechanisms for its interaction
- Examples: SCA, ESSOR, …
- Some limitations in characterizing platform performances

Security Support

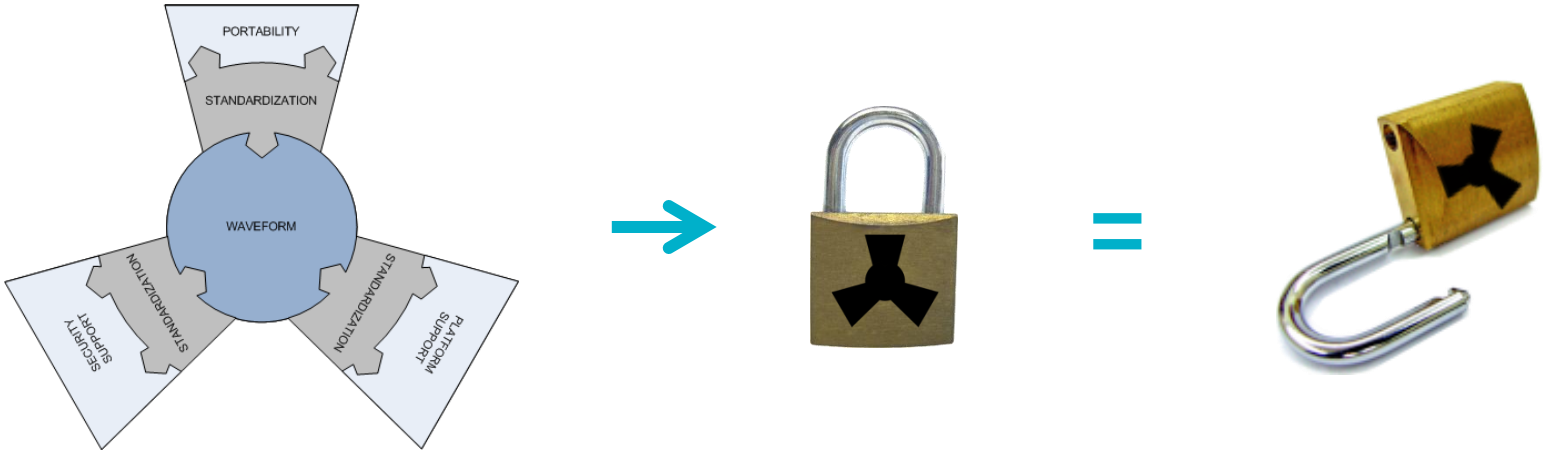
- Existing standards defining the functional security capabilities of the platform.
- Examples: ESSOR, IRSS API.

Portability

- Currently no existing standards widely used.
- WINNF initiative to provide set of rules covering this gap.

KEY CONTROL ELEMENTS: SUMMARY

> **Keeping the key elements under control guarantees independency, allowing to keep sovereignty in communications using SDR”**



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CONCLUSSIONS (I)

- In traditional communications the **core communication** capability is **tied to the radio hardware**.
  - This makes difficult to keep independency without replacing/modifying the hardware.

- Software Defined Radio provides a paradigm shift, defining the **waveform / platform separation**
  - This separation allows the platform **hardware reutilization**, associating the core communication capability to the waveform application
  - The **platform** is responsible for providing the **functionality** and **performance** needed by the waveform application to perform its function
  - This **dependency** on the platform **can limit** the ability to support some **legacy waveforms** or to evolve to **future waveforms**, hindering the desired sovereignty

CONCLUSSIONS (II)

- Software Defined Radio presents **additional challenges** for providing sovereignty in communications:
  - For SDR products (WF/PTF) providers
  - For SDR products users
- The following key control elements have been identified as drivers

  - **Waveform application**
  - **Portability**
  - **Platform support**
  - **Security support**

  } Waveform control

  } Platform control

- The previous elements have to be carefully analyzed and considered
  - When **defining** new platform/waveform (**SDR provider**)
  - When **selecting** a platform / waveform (**SDR user**)

QUESTIONS

ANY QUESTIONS?

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