sustainablySMART

'Sustainable Smart Mobile Devices Lifecycles
Through Advanced Re-design, Reliability,
and Re-use and Remanufacturing Technology'

1 Introduction

The EU funded Horizon2020 project sustainablySMART will change the lifecycle of mobile information and communication technology devices by developing new product design approaches. This includes enhanced end-of-life performance, re-use and remanufacturing aspects implemented on the product and printed circuit board level, as well as new re-/de-manufacturing processes with improved resource efficiency.

Mobile ICT products, such as smartphones and tablets, feature a significant environmental footprint whilst having a product life of few years only. Moreover, electronic devices incorporate a number of scarce and valuable natural resources, in terms of their electr(on)ic components or battery unit. Out of those scarce resources, several cannot be recovered efficiently and there is only a small credit regarding the environmental impact through material recycling.

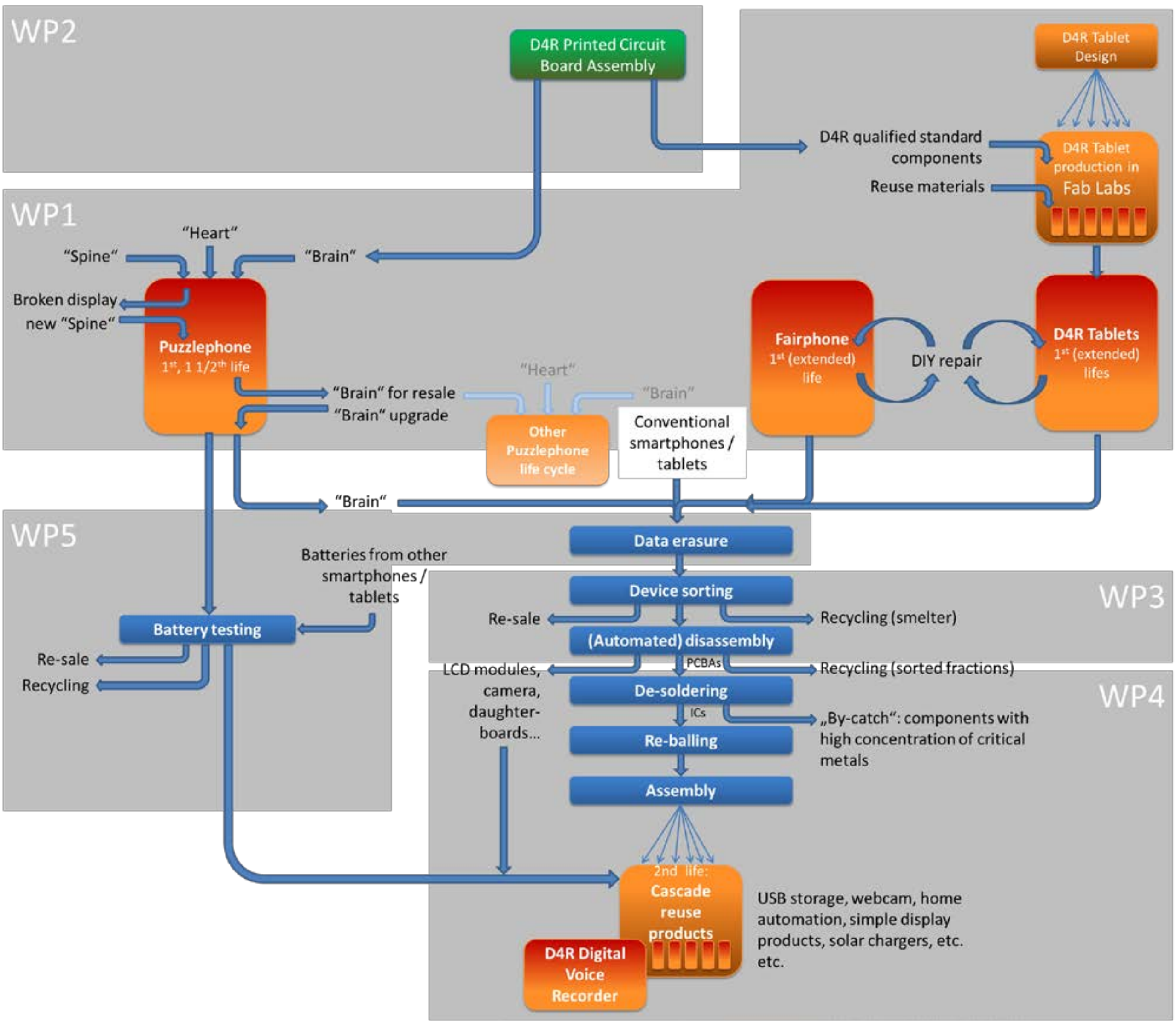
Consequently, only keeping those products or components 'alive' allows continuous efficient use of the once invested natural resources and emitted greenhouse gases. This approach implements the idea of a 'circular economy' or 'closed-loop economy', which subsumes approaches for keeping natural resources, materials, components and products in the industrial cycle beyond a first use phase. Loop-closing assumes materials recycling, reparability, refurbishment re-use and remanufacturing. Likewise, circular economy's implementation into corporate practice requires essentially new approaches how a company and its partners create value for the customer and how the company can capture the value.

2 Goals and Rationale

An effective circular economy approach for smart mobile devices prioritizes lifetime extension of products and components.

Modularized smartphones are a promising concept as they are easy to disassemble, to upgrade and to repair. Technically this calls for standardized interfaces.

Regarding the end of first life of such products, it is a challenge to tap into the upcoming wave of waste mobile ICT devices: Smartphones where introduced to the market at large only in 2009, tablets slightly later. We expect in the near-term future high return rates of these devices, which is confirmed by recycling companies. The market perspective indicates that we only see the beginning of a larger wave of discarded units. This is a perfect timing to invest in research to reuse and refurbish these products with sophisticated technologies. Apart, we consider technological evolution toward the Internet of Things, which may provide a wide field for cascade re-use of single components. Whereas, in the past, used electronics components were solely re-used in low-cost products, growing digitalization of our daily lives comes with numerous new product concepts, which could make perfect use of parts and components harvested from used smartphones and tablets.



Systemic product lifecycle approach of sustainablySMART

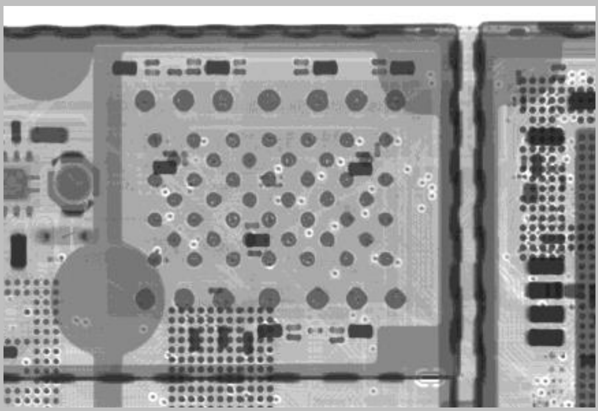
Main Goals

- Demonstrate the feasibility of a modular product approach for smartphones: The concept of a modular smartphone (Puzzlephone) shall be shown in an industrial environment.
- Demonstrate the feasibility of a 'design for circular economy' approach for more conventional mobile IT designs: On the example of the design of smartphones and tablets the implementation of environmental design criteria, i.e. long lifetime (reliability of target parts and components for second life / cascade reuse), reparability, design for manual and automated disassembly, implementation of verified data erasure compatibility will be demonstrated.
- For the first time in this industry's context, a printed circuit board assembly will consider explicit design targets for the 'Circular Economy'.
- Automated high-speed sorting and disassembly of end-of-life devices, enabled through a combination of advanced optical recognition; handling technology; tooling and robotics: The project implements a disassembly speed, which makes processing competitive with given high-volume destructive shredding processes, and with recycling the devices as a whole in a copper or precious metal smelter. The latter conventional processes mean that some key elements are recovered but many others lost inevitably such as, aluminum, steel, magnesium, indium, rare earth elements, gallium, silicon and tantalum.
- Implement 'smartness' for state-of-health monitoring in batteries: Health monitoring is essential for a quality tested battery reuse as it provides an alternative to lengthy full-cycle testing that is a major current barrier for battery re-use. Through monitoring algorithms embedded in the Smart Battery Specification data becomes extractable and in so doing, is made accessible at the point of potential battery re-use.
- Sound data erasure is a major barrier for product and memory re-use. The topology of solid state memory hinders straightforward erasure routines. Erasure processes shall thus be verified for solid state memory devices.
- High-quality desoldering and remanufacturing of semiconductor components for re-use: The project develops a desoldering, re-work and re-assembly process.
- Cascade re-use of selected components: Numerous potentially harvested components and subassemblies from smartphones and tablets meet the technical specification of a broad range of other products. They can be a sound substitute for new components.
- Develop a scientifically validated reparability score system, to allow for ranking products. Environmental product policies are meant to make use of these metrics.
- Re-use and remanufacturing requires new business models, acknowledging value generation happens among new actors in reverse supply chains. The new kinds of business models are already implemented for some low-cost products but not any close in sophisticated applications having higher reliability and quality requirements.

3 Project Workplan

sustainablySMART was kicked off in September 2015 at AT&S in Leoben, Austria, and scheduled to be fully implemented by 2019.

The project is structured into work packages (WPs), which are designed to cover the most relevant steps in a sustainable product life cycle of mobile IT devices. That is, from product design to recycling, and to re-use and remanufacturing.



Some work packages explicitly cover sustainable product design dimensions and production (WP 1, WP 2) as well as remanufacturing process technology (WP 3, WP 4, WP 5). The latter three work packages look at optimization of reverse logistics. They analyse such opportunities in a way asking how to secure the supply of products, components and sub-assemblies. This supply of products, components and sub-assemblies is not abundant available at the moment and thus the project may unlock new markets for re-used components and products. Innovation activities are linked and complemented by the WPs dedicated to developing appropriate business cases, assuring economic and ecological efficiency, and providing policy implications (WP 6, WP 7, WP 8). Altogether these WPs are designed to address all the direct and indirect aspects of a ‘recycling, re-use and remanufacturing factory of the future’ including proper business models.

‘WP1: Eco-Innovative approaches for product design of small mobile information technology products’ addresses product developments of modular smartphones, of a tablet, following D4R criteria and being optimized for production in a FabLab environment, and the D4R redesign of a dedicated business to business device, i.e. a digital voice recorder. Approaches with in the product development are modularization, longevity for lifetime extensions and other Design for Reuse and Remanufacturing approaches.

Aspects on a more specific technical level regarding system integration technologies are addressed in **‘WP2: Eco-innovative approaches for advanced printed circuit boards’**. Printed circuit boards are part of all target products. Sophisticated embedding technologies are a promising approach for modularization on the board level and a reduced technical and environmental footprint.

‘WP3: New technologies and automation solutions for the effective disassembly/ separation and recovery of advanced materials’ develops advanced sorting, handling, separation and disassembly technology to provide the capability to sort, disassemble and recycle end-of-life products. Main target are the harvesting of reusable components from smartphones, but as a “by-catch” certain critical materials could be extracted from the products.

Advanced recovery and refurbishment of components and sub-assemblies is addressed in **‘WP4: New Manufacturing and equipment concepts for re-use and remanufacturing’**. This includes desoldering of Ball Grid Array components, their rework and their re-use in new devices

‘WP5: New testing, processing and equipment concepts for verifying the condition of re-use parts: Data erasure and battery testing’ targets the quality assurance of re-used and remanufactured devices. More specifically, the state of the battery is essential for mobile technology. And concerns of data security may impede consumers and firms from giving away their devices to collection schemes. A verified process for data erasure on e.g. today’s eMMC memory components is under development.

The business potential of the technology developments will be analyzed in **‘WP6: Generation and validation of new business models’**, which has also the function of providing guidance for the technology tasks: how the research and innovation strategy should be adapted so that large scale market uptake is encouraged and becomes likely.

The project contributes to eco-innovation, productivity gains and better environmental performance of newly developed technologies. Related tasks are pooled in **‘WP7: Support for design and technology developments’**. It includes the evaluation of available technologies, of efficiency gains, and environmental assessments. Other work packages likewise receive generic guidelines for disassembly and the development of a reparability score.

Accounting that the implementation of radically new reuse and refurbishment concepts will require a sound public and policy environment, we installed a dedicated work page: **‘WP 8: Dissemination and policy impact’**. It will roll-out a comprehensive dissemination and communication plan, which is targeting at end users (social media and conventional media); at potential industry partners throughout the product lifecycle of mobile IT products, policy makers, and the research community.

4 Consortium

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Pro Automation GmbH	Austria
iFixit GmbH	Germany
ReUse-Computer e.V.	Germany
Technische Universität Wien	Austria
Instytut Tele- i Radiotechniczny	Poland
Semicon Sp. z.o.o.	Poland
Grant4Com Oy	Finland
RFND Technologies AB	Sweden
AT&S Austria Technologie & Systemtechnik AG	Austria
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