A Proposal to Deliver a Sustainable Internet of Things (IoT) and Internet of Energy (IoE) by Redistributing Energy Consumption Across an Integrated IoT/IoE Network Run on Decentralised Decentr Technology and "Deconomic" Models

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Note: *This document was produced as a result of ancillary R&D based around Decentr's core technology, and describes the efficiency achieved by extending our 100% decentralised "circular" dataflow concept into energy distribution and redistribution. With the energy industry still largely operating antiquated "linear" distribution and economic models, this solution shows great promise to reduce costs and wastage while promoting cleaner and more efficient "green" alternatives. (This model is expanded from* ***pg. 29*** **Impact,** ***section 2.03*** **Why Decentr is a Data Economy Solution for Individuals and Industry,** ***sub-section 3*** **Energy Savings as Part of an Integrated IoV** of our *Technical Whitepaper.)*

1. Excellence

1.1 *Radical vision of a science-enabled technology*

1.1.1 Ensuring the EU is a leader in a sustainable Internet of Things (IoT)

According to *IEEE Consumer Electronics Magazine* Editor, **Peter Corcoran**, energy is the primary determinant of the "*long-term sustainability of the Internet of Things*[1]." We propose that for the EU to continue to lead the world in **sustainability** initiatives while promoting a cohesive society at all levels requires an ***integrated*** **Internet of Things** (**IoT**) that – through a radical **redistribution of current user energy consumption** of **US $7 trillion** per year[2] – becomes near ***self*-sustaining**. Decentr aims to achieve this by ensuring that a next-generation IoT is primarily powered and funded by **Smart City** and **Internet of Things** (**IoT**) applications and devices (called "nodes") *themselves*. We propose that this existing **energy consumption** can be **efficiently redistributed** across an integrated IoT in line with **Internet of Energy** (**IoE**) principles to reduce reliance on current **primary power sources**, including batteries and grids.

A true IoE requires the implementation of IoT technology into distributed energy systems to **optimise the efficiency** of energy infrastructure and **reduce wastage**. This is achieved by creating a network of sensors that have various applications, such as power monitoring and **demand-side** energy management. Consumer appliances with IoT functionality are able to help **balance energy demand**: Decentr proposes to **optimise this balance** through the Research & Development (R&D) of a radically-new, 4G LTE-A compatible **hardware device**, called a "**Smart Chip Node**" (**SCN**). SCNs are designed to be integrated with IoT devices to redistribute **energy *and* collected data** across our IoT, assigning each with a **redistributable and payable** "value" that reduces overall network costs. The inspiration for our SCN derives from the way current blockchains are powered by individual devices (also called "nodes"): we propose that our chip and software can, in a similar way to the blockchain model, utilise (by analogy with the online "mining" activities of blockchain nodes) the **real-world IoT activities** of IoT device usersto power and fund an integrated, decentralised **demand-side IoT energy redistribution** solution for individuals and industry.

1.1.2 "Smart Chip Nodes" (SCN) set to power a next-generation IoT

Successful **SCN development** is critical for a sustainable and socially beneficial IoT: our SCN will ensure that all users (through Smart Devices fitted with an SCN) effectively "subsidise" our IoT through **existing internet and device usage**, meaning our proposed IoT does not consume **a single KWh more electricity** than users' current energy needs (and increasingly ***less*** energy as adoption of our solution increases across **rapidly integrating** IoT/IoE industries, applications and devices). This is achieved by our SCN deploying twin redistributable values: **data and energy** (data being a dimension current IoTs are not able not exploit as inherently valuable) through **community consensus** across our **IoT,** using a radically-new **consensus mechanism** based on **cooperative-game theory**[3]. For

[1]Corcoran, P. (2018). 2016 Index IEEE Consumer Electronics Magazine Vol. 5. *IEEE Consumer Electronics Magazine*, 5(4), pp.137-147.

[2]Siegel, J., Kumar, S. and Sarma, S. (2018). The Future Internet of Things: Secure, Efficient, and Model-Based. *IEEE Internet of Things Journal*, 5(4), pp.2386-2398.

[3]Cooperative-game theory describes the ongoing, qualitative and quantitative "proof-of-engagement" assessment of transmitted SCN user data among cooperating player (or "user") coalitions.

example, SNCs show promise to network **data-as-redistributable-value** (from wireless devices) and **energy-as-redistributable-value** (from systems in which access to power lines is trivial, whereby 5 or 3.3 V adapters enable USB-powered sensor networks to operate in perpetuity), with each **reducing wastage of the other**. This is not achievable on a large scale using current non-integrated IoT networks, which are typically limited in scope, with **less than** 10 nodes in a network that can **vary widely in power consumption**, depending on the application. Our solution to create this sustainable technological and **socioeconomic** paradigm is the wide-scale commercial deployment of our SCN; this radically-new System on Chip (SoC) design will transmit data from users' Smart Devices to their online Decentr account, where **energy/value** will be **efficiently and sustainably redistributed** across our integrated IoT network, with the **surplus energy conserved** being ***credited*** to users as **payable and tradeable economic** value, simultaneously realising an integrated **Internet of Value** [**IoV**] that will in part fund users' IoV applications and hence the wider network in perpetuity.

1.1.3 SCNs: Setting the standard for the future of IoT device connectivity

Our SCN will adhere to **4G LTE** standards (with in-built **5G capability**), which means connectivity between devices will match or exceed current speed and connectivity, **dramatically improving** stability and coverage of standalone devices, such as a laptop or tablet, as well as IoT devices, such as home routers and modems. The "LTE" protocol, which stands for "Long-Term Evolution" (i.e., ***how*** a developer reaches the speeds and connection standards set by the **International Telecommunications Union** [ITU] for 4G connectivity) will be progressed by Decentr to "LTE-A" or "Advanced", meaning we produce a chip with "true" 4G connectivity that is supported by our **operating software** (we will develop concurrently with our SCN). This is critical because the speed of data transmitted between devices **reduces friction** for users and devices, ***decreasing*** **energy wastage** through redistribution of energy while ***increasing*** **payable value** credited to the user. 4G LTE-A data connections are also critical for compatibility with existing devices: for example, **General Motors** (GM) has more than **1 million** vehicles on the road that are 4G LTE-A enabled and hence integration with an SCN is relatively straightforward. Services such as **Mobike** in the US, the world's largest smart bike sharing service, plans to use AT&T's 4G LTE connectivity combined with Qualcomm Technologies' LTE to improve their service, whereas in the UK, **YoBike** operates a similar "touch-and-go" service through a users own mobile device. We are exploring IoT-wide integration of **all these services** with our SCN with our research and commercial partners.

1.1.4 Surpassing current technological paradigms: Real-world applications for our SCN

Current IoT applications and devices are not developing in an **integrated** manner, and tend to deliver isolated, **incremental** improvements, which are in large part a product of the commercial constraints that require the development of immediate (and hence often limited) vertical solutions. In our view, for an IoT to truly benefit society requires **rapid *and* urgent integration** across current **fragmented** IoT networks: by doing so, our technology shows great promise for users' **real-world engagement** to **reduce costs** associated with the **activities and causes they support** due to **energy/value** redistribution created by these activities *themselves*: this will be achieved by our use of distributed "miners" (SNCs) that can be placed in different IoT devices, such as fitness and activity trackers and smartphones, transmitting data to a user's Decentr account, which can be stored for later potential fitness, health and analogous potential medtech and other purposes. This promises to not only improve **social cohesion** and the **promotion of independence** for the elderly, the vulnerable and those with special needs, but also **support** the costs of achieving this cohesion through the democratic reallocation of IoE/IoV resources through IoT-wide **community consensus**.

This real-world integration is set to be extended in conjunction with multiple industry applications as part of any decentralised application an SME builds on top of our open software. We have engaged with **Siemens** about compatibility with their Wi-Fi enabled home appliances as part of their **energy, infrastructure & cities activities**. Our SCN could in conjunction with ensuring **energy efficiency** communicate with "Smart" refrigerators that **credit** a Decentr user with **payable value** when, for example, healthy alternatives are ordered via a connected online shopping app (thus encouraging healthy living choices and a correspondent reduction in public expenditure on public and private medical services). We are currently engaging with **SmartHalo** with a view to complementing their **handlebar GPS and fitness tracking app** with our SCN. SmartHalo's Smart E-bike **usage data and policy and impact studies** suggest that integration of our SCN could enable a "smart" bike that **credits** a user with **payable value** when ridden at optimal periods (thus supporting the reduction of congestion and environmental damage and pollution). We have also engaged with **GM** about **social investment** in Decentr as part of their Corporate Social Responsibility (CSR) remit to promote **economic growth** through *science, technology,* engineering, and mathematics (STEM) education, vehicle and road safety and **community development**. Integration of our SCN could enable "Smart" hybrid vehicles that **credit** a user with **payable value** when recharged with electricity (thus promoting the continued purchase of increasingly cheaper, **environmentally friendly** fuel). The possible verticals are near-limitless, and we are continuing to explore these with our commercial and other stakeholders.

1.1.5 Overall Decentr objectives

Objective 1: Advance the investigation of a new IoT ecosystem focused on the redistribution of the energy generated by the digital footprint of users, enabling users to use the IoT more efficiently and with less friction while allowing them to exchange this digital footprint as real **value**. This includes:

01.1.- Researching new (energy-efficient) **consensus model hardware/software** applications and devices that redistribute the energy used by IoT nodes across the network.
01.2.- Studying new secure and low resource-demanding **cryptographic solutions** to effect energy redistribution by community consensus.

Objective 2: Evaluation of **social, ethical and economic** aspects of these decentralised strategies for their scale up implementation. This includes:

02.1.- Identification of legal aspects/barriers, including EU and global regulatory issues, and the study and implementation of realistic approaches to ensure compliance in line with issues of privacy vs. security vs. transparency of "**community consensus**" energy/value redistribution.

02.2.- Studying **sociological** aspects related to community engagement while identifying social/ethical advantages over traditional technology and economic models, including **sustainability** and energy/value sharing.

02.3.- Studying governance issues related to decentralised IoT networks to ensure ethical network use is part of the design architecture, reducing **network conflicts** and hence **increasing energy efficiency** and consumer convenience through reduction of network friction.

Objective 3: Deployment of a **Proof-of-Concept** (**POC**) with a view to validating the integration of the **SCN/consensus mechanism** and the effective energy/value redistribution among users. This includes:

03.1.- Roll out a **test environment** to validate technical aspects, including security and reliability, coupled with user and other stakeholder feedback.

1.2 Beyond the state-of-the-art: Current fragmented IoT paradigms are not the solution

Current IoT devices are capable of communicating between themselves and users; however, they suffer from having no **decentralised IoT network** that can record data and in true IoT/IoV fashion **sustainably redistribute energy** across the wider network for other purposes, such as domestic and commercial energy conservation, payments, etc.; the non-integration of IoT networks creates **friction** that wastes as much as **US $870 billion** per year[4]. The technological paradigm of blockchain was introduced to deliver on the promise of a "true" IoT; however, it is proving to be neither technically nor conceptually up to the task in the way that was hoped. Clearly, a more efficient IoV/IoT technology solution is required to turn IoT users' activities into **redistributable energy and usable value**. SCNs feed data into our radically-new **consensus mechanism**, which is backed by the security and immutability of **recorded data** received from users SCNs on their Decentr accounts. In this way, our new paradigm is based on "proof-of-engagement" as a radically-new, **principal source** of online **energy/value redistribution**.

Our R&D is based on three interrelated **Core Technology Elements** (CTE):

1. A decentralised **communications layer** that functions as a "**consensus mechanism**" (CTE 1) that can redistribute energy/value through community consensus that is transmitted by an SCN. Our CTE 1 essentially acts as a "user layer" for our IoT in the same way **windows** and **web browsers** act as a "user layer" for **HTML internet**;

2.SCN (CTE 2) that transmits **decentralised** user data that is redistributed in conjunction with CTE1;

3. A native **currency exchange gateway** (CTE 3) that can exchange **SCN data**into **fiat or digital** currency.
The **science-to-technology** breakthrough we are targeting as first POC is the integration of CTE 1, CTE 2 and CTE 3 to create a POC with SCN capability that will be validated in a test environment (M30).

[4]Yaghmaee Moghaddam, M. and Leon-Garcia, A. (2018). A Fog-Based Internet of Energy Architecture for Transactive Energy Management Systems. *IEEE Internet of Things Journal*, 5(2), pp.1055-1069.

1.3 Interdisciplinarity and non-incrementality of the research proposed

The nature of our research can in no way be seen as incremental due to the fact that the technology to **receive and record** Smart City/IoT device data that is **redistributable as energy/value** across a next-gen **IoV** does not exist: to achieve this will take the radically-new, non-incremental leap in research and technology Decentr proposes. The core research disciplines necessary are **hardware/software development**, **cooperative-game theory**, **Knowledge-Based Capital** (KBC), **communications/IoT networks**, as well as experience with **full-stack/hardware testing** and integration of large-scale public and private systems. Combined with our commercial and other stakeholders the ongoing research and exploitation of our R&D results will be undertaken in the same open, decentralised manner as the **development and deployment** of our decentralised SCN technology. This further highlights the transdisciplinary synergy of our R&D and the effectiveness of our **dissemination and communications** activities.

1.4 High risk, plausibility and flexibility of the research approach

Our research approach is based on the Design Science Research methodology (DSR), as we find this is a very effective way to "*build and evaluate*"[5]in conjunction with a combination of framework and agile methodologies. DSR artifacts can broadly include: models, methods, constructs, instantiations and design theories, and it is hence our chosen methodology as it encompasses the rigorous academic and commercial evaluation processes we have in place, coupled with the flexibility – pursuant to proposed **risk-mitigation measures –** to pursue either of several **development/technology** routes we have identified as viable to complete the artifact with greater functionality, security, reliability, scalability and **sustainability**.

2. Impact

2.1 Expected impacts

2.1.1 Building leading research and innovation capacity across Europe: Scientific and technological contributions to the foundation of a new future technology

EU and global R&D is set to benefit – not only from participating in the R&D of our technology – but in the resulting paradigm our breakthrough solution creates. Decentr will contribute a non-incremental technology designed to essentially keep what is good about current IoT applications, while re-distributing their **wasteful and non-integrated energy practices** in a socially fair, equitable and **sustainable** way. With this in mind, one of our primary goals is to ensure that truly global interdisciplinary collaboration on major new research projects will be possible as a legacy outcome of our R&D ***due to*** the elimination of friction – both **energy *and communications*** friction – that our platform achieves. **Replace communications friction** with an energy-efficient IoT – between users ***and*** devices – and this collaboration *itself*is set to help **fund future research**, promising a surge in technical, philosophical and scientific progress across many important and emerging disciplines not seen since the scientific revolution and the Enlightenment.

As a for-profit SME with wide-ranging experience commercialising radically new hardware and software, Decentr continues to engage in **interdisciplinary research** to advance our stakeholders' commercial goals within the context of advancing analogous academic, SSH and **Science & Technology** (S&T) fields. With this in mind, we maintain close ties with several universities (who are not Decentr partners but whose undergraduates and faculty are committed to **interdisciplinary research**). Decentr is thus set up to twin our development aims with cutting-edge research as a method of proving in practice our theories across a wide range of disciplines from social sciences to social policy, economic theory and blockchain and analogous technology breakthroughs with various cutting-edge, commercial EU research institutions at local and national level.

To achieve these goals our work plan is designed with two ongoing (WP6) in-depth, Whitepapers (as well as periodic reports; WP1, WP6) in core areas of **1) technological development** (**hardware** and **software**) and **2) SSH/ethical/legal/compliance implications** of our work, which act as "umbrella" WP tasks (T6.2, T6.3) that will be developed in **parallel with technology development**. In this way, we continue to ensure technological development is informed by research (and vice versa) at every step of Decentr's progress, allowing for real-time results to be both recorded and disseminated, in order that research methodology and aims can be adjusted accordingly, and insights fed back into the development phase that contribute to improved R&D outcomes. We have found that this combination of **agile development methods** and reactive, **interdisciplinary research** is the most effective way to stimulate cutting-edge development and research to achieve radically-new, commercially exploitable outcomes.

[5]March, S. T. and Storey, V. C., (2008). Design Science in the Information Systems Discipline: An introduction to the special issue on design science research, *MIS Quarterly*, 32(4), pp.725-730.

2.1.3 Gender balance in research and innovation

Decentr's research, technology development and evaluations include a consideration of **sex and gender equality** (beyond the traditional concepts of male and female) in line with sex and gender theories and issues. Of particular importance is the need to pay attention to sex and gender with regard to user requirements (WP2, WP3, WP5) and social and political considerations (WP1, WP6). Decentr has a **strong female representation** among the executive members, including the overall Decentr team. Decentr is committed to promoting equal employment opportunities and will establish a programme to make the **EU gender and equality policy** fully effective.

2.2 Measures to maximise impact

a) Dissemination and exploitation of results

2.2.1 Key Performance Indicators (KPIs) and Impact Transmission Mechanisms

The table below outlines the expected impact dynamics activated by the achievement of each objective and (sub)objective. Decentr will generate and disseminate research during and after development and launch, with a lasting legacy impact expected for ongoing EU technology and SSH research.

DECENTR (sub)objectives as per Section 1.1	WPs Involved	Associated KPIs	Impact Transmission Mechanism
01.1.- Researching new (energy-efficient) consensus models that replace "nodes" with IoT users. **01.2.**- Studying new secure and low resource demanding cryptographic solutions to redistribute energy saved.	WP1, WP2, WP3, WP4	Ø Completion of a White Paper on new SCN and consensus model in conjunction with cutting-edge researchers, including **School of Sociology and Social Policy**, Leeds, **Max Planck Society** (De.) and commercial partners including **General Motors** (GM), **Siemens** and **SmartHalo**.	**1)** Publication of White Paper on our website and distribution to our research and commercial partners. **2)** Research dissemination and analogous communication activities amongst the scientific community to create awareness/ engagement.
02.1.- Identifying legal aspects/ barriers/studying and implementing realistic approaches to ensure compliance. **02.2.**- Identifying social/ethical advantages over traditional technology and economic models, including sustainability and energy sharing. **02.3.**- Studying governance issues related to decentralised 4G LTE-A networks to ensure ethical network use.	WP1, WP3, WP4, WP 5	Ø Development of ethical legal/compliance White Paper (including privacy/ regulatory/ compliance) in conjunction with SSH partners (IAAD), **School of Sociology and Social Policy**, Leeds, **London South Bank University** (LSBU; sociology and social policy); in conjunction with; Ø Closed testing of POC with commercial partners.	**1)** Publication of White Paper on our website and distribution to our research and commercial partners. **2)** Wider engagement of non-commercial stakeholders in target groups identified by IAAD, in areas including survey and research in cooperation with SSH, RRI, Open Science, DEOR and IIRS key actors at a national level.
03.1.- - Roll out of a test environment to validate technical aspects of SCN prototype/commercial viability.	WP1, WP 6	Ø Ongoing validation of our SNC/consensus mechanism including security and reliability and interoperability, coupled with stakeholder feedback.	**1)** Dissemination and exploitation of test environment results/consultation with SSH/ compliance/ regulatory partners at local and national level led by SYN with support from IAAD.

Figure 1 Decentr Objectives and KPI's

To this end, the actions/channels described above will comprise: platform and website; events and interdisciplinary workshops; summits and formative itineraries; conferences; articles and press releases; scientific publications; professional associations and scientific discussion forums; training activities; observatory; synergies with existing networks through the OECD, DIHs, commercial partners and others. Our Proof-of-Concept (POC) will allow for the **exploitation of the R&D results** through experimentation with the technology. This will in conjunction with our main stakeholders and actors help to define the most immediate **commercial application** of the results, and therefore an effective exploitation strategy for a roadmap to market take-up of this disruptive technology. For the proper management of the results and the protection of the knowledge gained, the exploitation plan designed in WP1 and WP6 will include the **IPR management strategy** and will provide a **sustainable strategy** for the support of the R&D results and its roadmap to the large-scale adoption by stakeholders and end users.

Innovation and exploitation strategy

The goal of the exploitation plan is to develop strategies for the exploitation of the R&D results, explore their wider use, **sustainability and commercial feasibility**. The initial exploitation plan was launched as soon as a clear description of the expected outcomes was documented. It incorporates all actions involved in the establishment of an environment for the wider use of Decentr results, and the potential for sustainability of R&D outcomes – including the

individual exploitation plans of commercial partners and other stakeholders based on their commercial, R&D and other contributions as aligned with their commercial development strategy. Decentr will continue to carefully examine the possibilities for commercial actions during and after the lifetime of the R&D and platform launch (WP6). Collaboration will be regulated in compliance with the guidelines as part of the **Company Agreement** (CA). The opportunities to exploit the results achieved by Decentr will be different for **individual commercial partners** and other stakeholders, and they will depend on the stage of development of potential products and services. Decentr will in conjunction with stakeholders identify key sectors on which it will implement and handle its strategy on innovations that stem from the R&D results.

IPR (Intellectual Property Rights) Management

For Decentr it is very important to have explicit rules on how to access background and results and how to **ensure the protection of intellectual property**. Therefore, Decentr as an LLC will work on a Company Agreement (CA), which will take into account IPR issues to support common and individual dissemination/ exploitation strategies. The CA will be developed taking into account the following preliminary agreements:

1) **Exploitation of the R&D results**: it is the understanding of Decentr that knowledge and background information will be made available to stakeholders under the conditions specified in the CA if they are necessary to perform the integration activities and relative work required during the development and launch phases.

2) **Results are owned by the contractor generating such information or result**. Each contractor shall make available its results, on a royalty-free basis, to other contractors to the extent that such information is necessary for the production of their own Results.

3) **Background and results knowledge will be made available, on a royalty-free basis, to all stakeholders** for dissemination, commercial and non-commercial research and demonstration, interoperability of software and academic purposes in respect to the intellectual property rights of the stakeholder or commercial partner generating this knowledge. Note that Decentr will exploit components owned by the company.

4) **For any other purposes**, background information and results will be made available to **all stakeholders** for exploitation purposes at **fair and reasonable conditions**, with respect to the normal commercial conditions applied by the Decentr as the developing LLC.

Decentr will develop the agreement on IPR issues to be included in the final version of the CA. It will regulate obligations and rights of the participants, and will be prepared no later than the contractual start date. The final CA will make explicit reference to important administrative points such as decision procedures, risk management strategies, legal aspects regarding hardware and software to be used/produced, trademarks, patents and rights of each stakeholder in the exploitation of results.

Data Management Plan

Decentr intends to participate in the EU Open Research Data Pilot, which is in line with our views on transparency in science supported by public funds. For this, a deliverable consisting of a first draft of our Data Management Plan (DMP) will be produced in the first six months of WP1 (Task 1.4, Deliverable D1.5) and further developed from their. It will be produced according to the Guidelines on Data Management in H2020, describing: (i) the data sets that will be collected, processed or generated by Decentr; (ii) the data management life cycle for these data sets; (iii) the methodology and standards following which data will be collected, processed or generated; (iv) whether and how the data will be shared and/or made open; and (v) how the data will be curated and preserved. Decentr is mindful of standards contained in, but not limited to:

The General Data Protection Regulation:

- ISO/IEC 29100:2011 and ISO/IEC 27001:2005 - both on Security.
- Charter of Fundamental Human Rights of the European Union 2009.
- Council of Europe's Convention for the Protection of Individuals regarding Automatic Processing of Personal Data 1980.
- Guidelines on FAIR Data Management in Horizon 2020 (FAIR Guiding Principles: Findable, Accessible, Interoperable, Reusable).

b) Communication activities

The communication strategy is designed in WP 1 and defines a set of actions and measures to reach the different target audiences while supporting the execution of different aims aligned to Decentr's objectives. These communications activities include:

- The promotion of the scientific achievements in different research fields while engaging experts (including SSH; sociology and social policy) and commercial/technical, as well as community outreach to leverage the development of the technology proposed.
- Informing legal, ethical and social experts about the advantages/features/barriers inherent to this technology to foster large-scale adoption of SCNs/IoT.
- Informing technology providers (including telcons, etc) with a view to generating a critical mass of experts working in R&D activities related to this technology while enrolling strategic actors, including SMEs, in technology development and application.

Section 3. Implementation

3.1 Research methodology and work plan – Work packages, deliverables

Management structure, milestones and procedures

Our management structure reflects the decentralised tech we are building: our management approach is based on **sensemaking theory**, which is a critical framework for identifying and detecting high risk situations while helping "*organisations address uncertain or ambiguous situations*"[6]. Sensemaking theory allows Decentr to use agile methodology to solve developmental problems without needing to consult team leaders or participating stakeholders, improving overall operational efficiency. Sensemaking theory allows for maximum flexibility and autonomy of approach while fostering outcomes based on a robustly networked, collaborative process of creating shared awareness and understanding. This ensures **milestones** are met within each domain, supporting overall SNC hardware development whilst innovating with individual operating software. Our approach, combined with ongoing cost-benefits analysis (CBA), is instrumental as part of our **risk mitigation** strategy due to ongoing stakeholder input promoting the development of benchmarks to compare R&D approaches and outcomes.

Decentr and our stakeholders

The interdisciplinary nature of our R&D represents significant **development and communications** advantages. In conjunction with our commercial and other stakeholder we will ensure immediate and ongoing impact of the R&D results. Our breakthrough decentralised IoT paradigm is **reflected in** our decentralised systems and transdisciplinary research expertise, as well as the **complementary** research experience and **commercial acumen** of Decentrand our stakeholders, which will greatly mitigate R&D risks: the Decentr team have **wide commercial experience** with implementing large-scale IT projects and bringing innovative technology to market, combined with the relevant technical expertise to **commercialise** our radically-new technology. Decentr's experience with business and workflow processes will ensure our team's complementary skills and disciplines in large-scale projects will be maximised as follows: **1)** CTE 1 **communications layer/ consensus mechanism**, **2)** CTE 2 **SCN/hardware** development, **3)** CTE 3 **native currency exchange** development, and **4) full-stack integration/hardware** testing, with complementary interdisciplinary stakeholder and commercial partner crossover as regards integration and testing of **individual and full-stack hardware and software systems**. As a result, our flexible yet integrated development processes are set to yield **32%** greater efficiency than isolated CTE development, based on our benchmarked CBA.

[6]Garstka, J. and Alberts, D. (2004). *Network Centric Operations Conceptual Framework Version 2.0*. U.S. Office of Force Transformation and Office of the Assistant Secretary of Defense for Networks and Information.

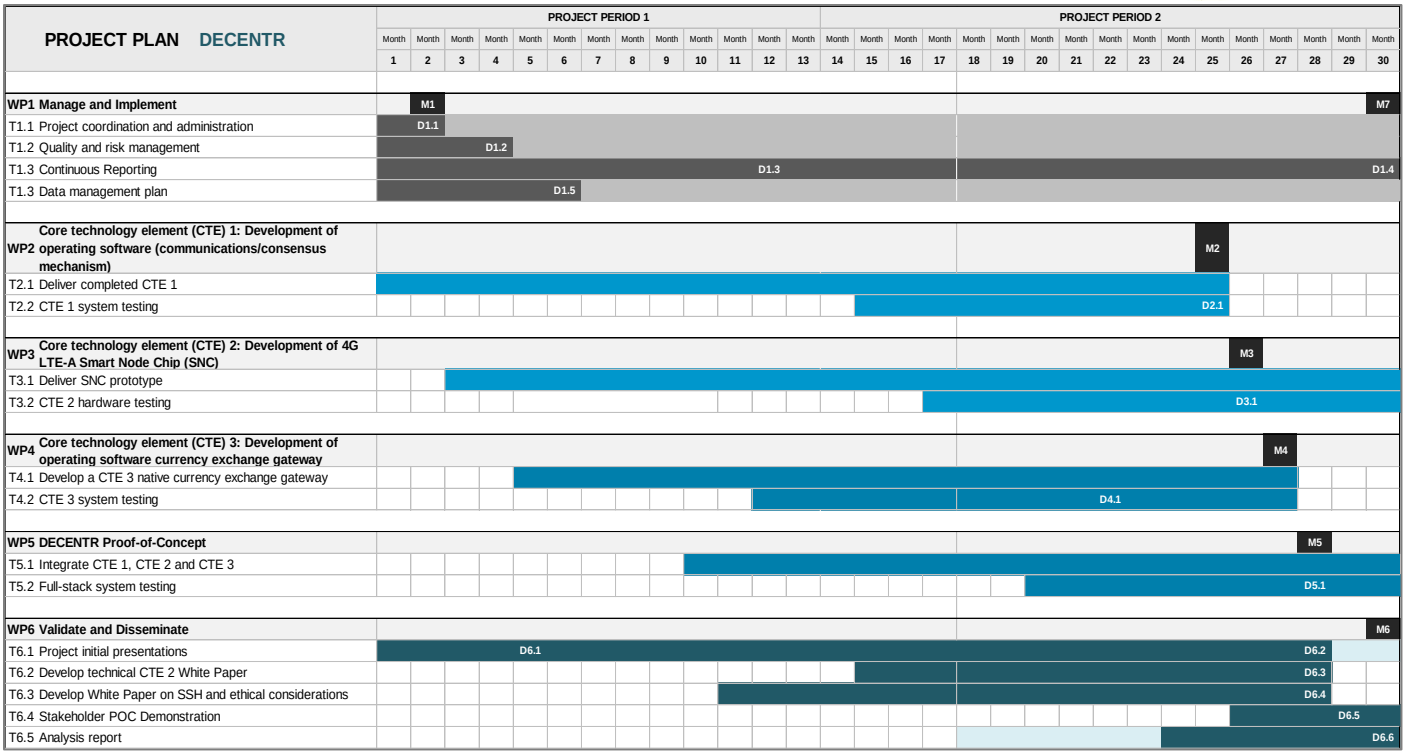

Table 1.Workplan

WP NUMBER	1	START	M 1
WP TITLE	**Manage and Implement**		

OBJECTIVES

This WP sets the stage for Decentr in administrative and R&D coordination terms, while monitoring the progress of each WP. The coordinator will support the communication, risk assessment and quality control and as such will deliver the periodic reports to the Commission, ensuring optimised use of resources, in line with the development plan and optimal Decentr team and stakeholder performance.

DESCRIPTION OF WORK

T1.1 – Coordination and administration: *includes effective communicative exchange among all stakeholders, assisting and monitoring the scientific work, overseeing R&D, collecting and delivering reports on time, while maintaining communication with all commercial and other stakeholders.*
T1.2 – Quality and risk management: *Adaptation and review of the work plan in line with monitoring feedback and a liaison with WP leaders.*
T1.3 –Continuous Reporting: *This task will contribute to the final documentation, which will summarise the methodology, achievements and lessons learned from all Decentr WPs.*
T1.4 - Data management plan: *A specific task has been introduced to make sure all generated data is properly collected accessed, curated, preserved and eventually made public after any possible ethical issue has been cleared.*
Dependencies with other WPs: *This WP, addressing management tasks, has direct dependencies with all the other WPs.*

DELIVERABLES

D1.1 - Decentr charter (M2): *This contributes to a good shared understanding so that all stakeholders have a clear understanding of our aims and goals, which provides a sound basis to pursue effective communication.*
D1.2 - Quality management plan (M4): *This report defines quality management strategies, verification procedures, progress reporting formats.*
D1.3 - Status report and financial report (M12): *After the first and second R&D phase, a status report will be delivered, which will not only showcase R&D accomplishments, but also identify all obstacles up to this date.*
D1.4 - Decentr documentation and final report (M30): *Decentr documentation will describe how objectives were achieved.*

D1.5 - Data management plan (M6): *The data plan describes how data will be generated, collected accessed, curated and preserved.*

WP NUMBER	2	START	M 1
WP TITLE	**Core Technology Element (CTE) 1: Development of Communications Layer**		

OBJECTIVES

The overall objectives of this WP are to complete CTE 1 software development of **communications layer** integrated with our radically-new **consensus mechanism** based on cooperative-game theory.

DESCRIPTION OF WORK

T2.1 – Complete operating software for communications/consensus mechanism user layer: *This task is designed to complete the integrated communications/consensus mechanism operating software and front-end UI/UX work.*
T2.2 – CTE 1 system testing: *This is to validate the public exposed interfaces to verify separate software systems operate well together.*

DELIVERABLES

D2.1 - A working proof-of-engagement CTE 1 communications/consensus mechanism user layer POC (M25): *This POC will be design-ready for integration with CTE 2 and CTE 3.*

WP NUMBER	3	START	M 3
WP TITLE	**Core Technology Element (CTE) 2: Development of SCN**		

OBJECTIVES

The overall objectives of this WP are to deliver CTE 2 Smart Chip Node (SCN) POC

DESCRIPTION OF WORK

T3.1 – Develop a viable SCN POC: *This task is designed to develop a viable 4G LTE-A SCN compatible with CTE 1 communications/consensus mechanism operating software.*
T3.2 – CTE 2 hardware testing: *This is to validate hardware functionality and compatibility with CTE 1 and CTE 3 operating software.*

DELIVERABLES

D3.1 – SCN POC (M26): *This will deliver a 4G LTE-A SCN compatible with CTE 1 and CTE 3 operating software.*

WP NUMBER	4	START	M 5
WP TITLE	**Core Technology Element (CTE) 3: Development of 3 Native Currency Exchange**		

OBJECTIVES

The overall objective of this WP is to develop a CTE 3 native currency exchange gateway that will allow users the flexibility of converting credited energy/value into digital currency and fiat.

DESCRIPTION OF WORK

T4.1 – Develop a CTE 3 exchange gateway:*This task is designed to create a gateway based on atomic swaps to*

enable the exchange of UVC into currency without needing a centralised intermediary.
T4.2 – CTE 2 system testing: *This is to validate the public exposed interfaces to verify separate systems operate well together.*

DELIVERABLES

D4.1 - A CTE 3 native exchange gateway (M22):*This will deliver a native currency exchange gateway that offers decentralised settlement and liquidity services at both the payment and transaction destination.*

WP NUMBER	5	START	M 10
WP TITLE	**Integrated Decentr Prototype**		

OBJECTIVES

The overall objective of this WP is to integrate CTE 1, CTE 2 and CTE 3 to create a pilot programme-ready Decentr prototype.

DESCRIPTION OF WORK

T5.1 – Integrate technologies developed (CTE 1, CTE 2 and CTE 3) to deliver POC:*This will deliver a Decentr POC powered by users as devices (or "nodes") with full SCN capability.*
T5.2 – Full-stack systems testing: *This will ensure the whole system is working and ready for stakeholder validation.*

DELIVERABLES

D5.1 - A fully integrated Decentr prototype (M28): *This will deliver a fully integrated CTE 1, CTE 2, CTE 3 POC with decentralised backend/frontend operating software/SCN capability.*

WP NUMBER	6	START	M 1
WP TITLE	**Validate and Disseminate**		

OBJECTIVES

This WP ensures IIRS dissemination and exploitation of results with a view to raising awareness of the Decentr and its results: this will be done by facilitating further exploitation and development, encouraging European and international cooperation and integration in the relevant business areas, providing an effective linkage between all stakeholders, creating and maintaining exploitation strategy / Business plan / Sustainability plan with a view to developing a medium-scale pilot programme.

DESCRIPTION OF WORK

T6.1 – Dissemination of Decentr results to stakeholders: *A dissemination plan will be set up for each stakeholder, including selection of relevant events, means of publication and schedule. Social media accounts will be created on LinkedIn and Twitter with supportive campaigns. Throughout the R&D phase Decentr will also organise at least one workshop addressing researchers, SMEs and other stakeholders operating in the Decentr domain, and one summer school for students researching in the Decentr field.*

T6.2 – Write and publish technical CTE 2 White Paper: *Dissemination of technical White Paper on new consensus model to all stakeholders and wider research, scientific and stakeholder community.*
T6.3 – Develop a White Paper on SSH/ethical/legal/compliance considerations: *Develop White Paper with our commercial partners and other stakeholders to highlight social, ethical and regulatory considerations presented by our technology development and innovation.*
T6.4 – Exploitation of results/final-phase recommendations: *One of main objectives of the exploitation of R&D results, including White Papers, to maximise R&D results and translate them into commercial benefits for the all stakeholders (public services). IPR of all parties will be managed to reach mutual benefits and usable results.*
Dependencies with other WPs: *This WP makes use of all the publishable results and conveys them to the wide public in order to promote our R&Ds findings while raising awareness on the applications of Decentr.*

DELIVERABLES
D6.1, D6.2 - Decentr initial presentations (M5, M28): *A report containing detailed information on the aims, objectives, work processes and the current state of Decentr R&D, including newsletter subscriptions.* **D6.3 - A White Paper outlining CTE 2 conceptual and technical framework (M28):** *This White Paper will describe specific and overall implications of the CTE 2 developmental and operative framework, disseminated to scientific and commercial partners.* **D6.4 - An SSH/ethical/legal/compliance White Paper (M28):** *This White Paper comprises input from all stakeholders as well as new, young, **first-time FET independent researchers**, updating, social, ethical and compliance issues in line with technical development.* **D6.5 - Decentr POC (M29):** *Demonstration of POC to stakeholders.* **D6.6 - Analysis Report (M30):***This report will communicate and disseminate overall R&D results (developmental, ethical, SSH, commercial) to all stakeholders and recommend the scale and nature (demographic, duration) of proposed pilot programme.*

Figure 2. Work-Package dependenciesTable 4. List of Deliverables

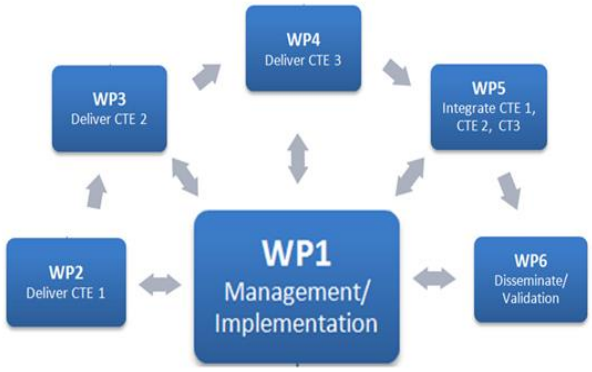

Figure 2 Illustrates the interdependencies of the different WPs.

The WP structure mirrors the Decentr concept and approach described above. Decentr management as an core activity (WP1) will ensure efficient coordination and reporting of R&D outcomes. Furthermore, it will also ensure the correct management of financial resources. WP2, WP3 and WP4 focus on the delivering of the CTEs to be integrated in WP4, which provide crucial inputs for the development of the POC. WP6 ensures a tailored dissemination/communication plan and POC Demonstration.

M#	MILESTONE NAME	WP#	M#	MEANS OF VERIFICATION
M1	Decentr Charter	**1**	**2**	Decentr Charter report completed
M2	CTE 1, CTE 2 operating software completed.	**WP2, WP4**	**25**	Validate by systems testing/internal stakeholders.
M3	CTE 2 SNC prototype completed.	**WP3**	**26**	Validate by systems testing/internal stakeholders.
M4	POC integrated (CTE 1, 2, 3) with 4G SCN capability.	**WP2, WP3, WP4, WP5**	**27**	Validate by full-stack testing/internal stakeholder.
M5	Stakeholder Decentr POC demonstration	**WP1, WP6**	**28**	Validate by commercial and other stakeholders
M6	Fulfilment of dissemination, exploitation planning and communication activities	**6**	**30**	Fulfilment and reporting of dissemination and communications plan
M7	POC documented and finished	**1**	**30**	Final documentation and financial reporting completed

Table 2. List of milestones

The following table gives an overview of possible risks, involved work packages and proposed mitigation measures. Once risks have been identified and assessed, all techniques to manage risk fall into one or more of four major categories: **Avoidance, Reduction, Sharing, Retention**.

DESCRIPTION OF RISK	WP	PROPOSED RISK-MITIGATION MEASURES
Defaulting team member or stakeholder (low)	1 – 6	**Sharing**: Alternative distribution of defaulting team member or stakeholder's tasks or involvement of substitute tam member or stakeholder

Communication problems amongst team and stakeholders (medium)	1 – 6	**Avoidance and Sharing**: Clear communication rules and support by modern communication technologies
Disputes and conflicts among team and stakeholders (low)	1 – 6	**Avoidance and Reduction**: Effective and professional conflict management involving all conflict parties equally
Lack of internal work capacity (medium)	1 – 6	**Sharing**: Outsourcing workload or coordinating with team members and stakeholders
Possible deliverable or milestone delays during R&D (low)	1 – 6	**Avoidance**: Efficient management will keep this risk to minimum by using strict internal schedules
CTE 2 Consensus Mechanism Ineffective (low)	3 and 5	**Reduction**: Adjust technical requirements in line with cooperative-game theory.
SNC lacks interoperability with operating software (low)	2-5	**Reduction**: Adjust hardware/software requirements for greater compatibility.
SNC lacks interoperability with external 4G devices(medium)	2-5	**Reduction**: Adjust hardware/software requirements for greater compatibility.

Table 3. Critical risks for implementation