1. Other positive effect on the market
   1. Increasing the level of R&D and innovations in Europe

*Description of how the project will increase the level of innovation and R&D in the sector and the European economy and society.*

* 1. Impact of the Project on Employment and New Investments in Europe

*Estimation of the quantitative and qualitative impact of your project on direct and indirect employment and training in European economy and society new investments in Europe.*

Schuman Associates recommendation:

* Give exact figures on the number of direct jobs that will be created.
* Describe the different kind of positions that will be generated, operational/finance/etc
* Specify if there will be specific trainings that will take place for the employments.
* If there are follow-up investments that will result due to the project, specify them here.
  1. Environmental protection and energy dependence

*Description of the project influence on environment protection and on the reduction of energy dependence.*

*Description of planned positive effects on the life cycle assessment and, if possible, substantiated with key figures/target numbers, such as savings in tons of CO2 equivalents.*

Schuman Associates recommendation:

* Mention any positive effects you might expect the project to have on the environment
* It i
* Describe the different kind of positions that will be generated, operational/finance/etc
* Specify if there will be specific trainings that will take place for the employments.
  1. Coordination problems

*Due to scale and complexity of the IPCEI explain the difficulty to work together particularly with:*

* *RTOs (not the same objective)*
* *SMEs, suppliers and customers (it’s easier to work in customer-supplier logic than in a cooperative)*
* *Competitors and sectors actors*

*Explain the difficulty due to the necessity to coordinate such a project with such divergent interests.*

* + 1. Coordination failures between companies and research organizations

The very large number of public and private initiatives to define a mainstream trend to develop the telecommunication technologies creates important coordination problems. Academia and businesses differ greatly in many aspects. The goal of scientists’ activities is the growth of knowledge, while for companies the principal motivation is profits. Each one tends to underestimate or even discard the objective that the other pursues. Reward modes are also orthogonal: an important scientific discovery will contribute to the reputation of the team that makes it, while a significant innovation will enrich the company that develops it. Finally, scientific results acquire their value when they are shared through scientific publications, while businesses’ R&D&I results get their value if they are patented. The reconciliation of the two approaches is possible but often causes misunderstandings and conflicts.

The difficulties that companies and research organizations face when trying to work together are well documented. In particular, these relations are known to be much more complicated in Europe than in the United States. A lack of investment by public and private actors inhibits knowledge transfer by directly limiting the transfer capacity between public research organizations and companies, leading to limited communication and increases in coordination failures.

In the case of the European next telecommunications sector, this lack of coordination between research organizations and companies in most Member States is a major systemic failure. Its outcome is a deficit of growth and competitiveness as compared to other parts of the world, particularly Asia and North America. This is reflected in the loss of momentum of European players in research and innovation capacity, particularly visible in the low impact of their patents worldwide.

In addition, partnerships between research organizations and companies tend to be set up only at a local dimension. They prefer to collaborate when they know each other well and are close, which leads to neglecting other partnership opportunities that could be more productive from the scientific and technological points of view. The lack of cross-frontier public funding leads some public research organizations to focus solely on local companies for partnerships, or rather the opposite, to develop fully open business models where the benefits of European research efforts, particularly within cooperative projects.

The IPCEI on Microelectronics will promote an intense cooperation between academic partners and industrial partners from numerous Member States. Market forces alone cannot lead to such cooperation. This major European R&D&I partnership will significantly intensify scientific and technological exchanges between European players from academia and from next generation battery industry. As part of the IPCEI on Microelectronics, the research agendas of academic laboratories and companies will be much better aligned, and exchanges will transcend the borders established by local tropisms. Thus, the ambition of R&D&I activities can be of a much higher level.

* + 1. Coordination failures between European research organizations themselves

Most European research organizations suffer from sub-critical size to engage in advanced research in next generation telecommunications infrastructre. Such research activities require heavy resources in manufacturing equipment and characterization. No European public research laboratories owns the full set of equipment included a complete production line to carry out their research activities.

The sub-critical size of European research organizations, particularly compared to the United States, combined with a lack of coordination between them, leads to dispersion and redundancy. Important efforts are made on some research topics without exchange of information, leading to a deteriorated scientific productivity, while other topics are neglected. The setting up of in-depth discussions within each technological field of next generation networks.

The IPCEI on Microelectronics will mobilize and bring together many European research laboratories, thus making it possible to overcome the lack of coordination that characterizes them. As part of the project, the redundancies will be removed, synergies and exchanges will be developed to pursue common R&D&I objectives in the field of telecommunications to develop infrastructure for 5G and beyond.

* + 1. Coordination failures between SMEs and industry leaders

The IPCEI on Microelectronics will provide SMEs with access to R&D&I activities and high-level infrastructure that they would not have accessed in the absence of the project. Without State aid, DT would work with some of these SMEs in a "client-supplier" logic, rather than associate them as partners and allow them to anticipate technological breakthroughs. Thus, most of these SMEs simply would not have the ability to be working on these technological areas.

The State aid encourages many European SMEs collaborate and invest in R&D&I, by pooling and sharing risks. The project will enable the actors to achieve collectively the critical size that is needed to carry out advanced telecommunications infrastructure. European SMEs in the microelectronics sector will coordinate R&D&I activities with high levels of ambition and risk.

* + 1. Coordination failures of a very large-scale R&D project

The scope, scale and the scientific and technological complexity level of IPCEI on Microelectronics require joint work amongst a very large number of actors (xx), most of them industrial companies and some being public research organizations or university laboratories.

The intensity of collaboration inside IPCEI on Microelectronics is very important, program partners will work in a very strong interdisciplinary sense, which could not be mobilized without the State aid. The results obtained by each partner will impact the other partners' actions. The collaboration must be coordinated in a very close and dynamic way, in order to get the best results from trials and error experiences of R&D&I activities, as well as to reorient all work packages as a result of the progress of each partner, so that the R&D&I program can achieve its objectives. Round trips will be necessary between the different partners to coordinate their work, in order to remove the technological barriers that will be identified.

State aid to partners of the project IPCEI on Microelectronics deeply strengthens the coordination of the consortium. The disbursement of the public funding will be spread over the XX years lifetime of the project, thus necessitating a very close monitoring by public authorities through progress reports, semi-annual milestones, etc. All partners know that they must progress together towards the achievement of IPCEI on Microelectronics objectives to get the public funding. Thus, the State aid gives each partner very strong dynamic incentives to overcome the difficulties of such a large-scale and long-lasting project. It makes it possible to set up a very large European R&D partnership which constitutes an efficient and responsive mode of organization, able to catalyze synergies between partners and ensure gathering and coordination of the broad spectrum of necessary sector skills for the realization of such an ambitious project. Major European players in the telecommunications field will all work together for the first time in a collaborative approach around a major unifying R&D&I program, lowering the technical and economic barriers.

* + 1. Coordination failures associated with contractual incompleteness

The State aid will also limit the coordination difficulties related to the contractual incompleteness of major collaborative R&D&I programs. It is well known that R&D&I contracts are incomplete, that is, they cannot anticipate or take into account all possible situations and all future contingencies. Indeed, R&D&I programs are characterized by high uncertainty: not all results can be determined in advance ("serendipity"), unanticipated scientific and technological hurdles can arise, with a potentially strong impact on the program's calendar or costs, successes or failures can come from where they were not expected, etc.

Contractual incompleteness may encourage opportunistic partners' behaviors, reducing their commitment to the collaborative R&D&I project. In such context, cooperation is rendered very unstable by the alternative opportunities that are offered to the partners. The occurrence of an unforeseen event in the contract can lead to a chain of reactions from the partners, putting at risk the primary purpose of the partnership. Naturally, this risk is all the more important as the number of partners grows and the research is of a high level of complexity, which is very clearly the case for the project IPCEI on Microelectronics.

A very large collaborative R&D&I project like IPCEI on Microelectronics is characterized by a high uncertainty, which means the occurrence of unpredictable events during the project. A partner could invoke the occurrence of an unforeseen contingency in the contract to defend opportunistically his interests. The collaboration contract cannot therefore prevent these behaviors. Sanctions or penalties cannot solve this problem: a sanction can only apply over a behavior considered as deviant by reference to foreseeable configurations provided for in the contract.

Secondly, the interests of the partners may diverge over the content of the program, or its objectives, or even its costs, as it progresses. This is common in a very large collaborative R&D&I program like IPCEI on Microelectronics, since project developments are very likely to deviate from the initial plan. Therefore, each of the partners would tend to influence the program in such a way as to favor its interests to the detriment of the common interest of the consortium, while it would be hardly possible to invoke the contract to prevent it (in particular, through penalties provided for in the contract). This may for example involve renegotiating the allocation of costs between the partners, to the detriment of the effectiveness of the project.

Thirdly, it is very difficult, if not impossible, to anticipate and define in an exhaustive way the totality of the results of a very large R&D&I program. Thus, one of the partners might be tempted to appropriate some unanticipated results of the program by claiming that they would result from R&D&I activity outside the program. Here again, applying fines could not address anything, because of the intrinsic uncertainty of the very large collaborative R&D&I programs and the resulting contractual incompleteness.

The examples above, where a partner might be interested in adopting opportunistic behavior, are not exhaustive. However, they provide an overview of the wide range of opportunities for partners in a very large collaborative R&D&I program like IPCEI on Microelectronics to derive a profit from the program at the expense of the common interest of the partners. Thus, although collaborative R&D&I contracts are essential for framing partnership relations, they may reveal a limited effectiveness in managing the divergences of interests that do not fail to appear, especially in the context of a program as expensive, long and complex as IPCEI on Microelectronics. Since it is very difficult to anticipate all situations in which a partner might have an interest in opportunistic behavior, or even to prove this type of behavior, it is impossible to provide for an appropriate system of sanctions.

State aid makes it possible to reduce a priori the opportunistic behavior that may result from contractual incompleteness, and thus facilitates the coordination of IPCEI on Microelectronics partners. Indeed, for each partner, the risk related to the implementation of the program will be shared with the public authorities, limiting its potential financial losses in case of failure. This sharing of risks reduces each partner's incentives to use opportunistically contractual incompleteness to his advantage.

* 1. Imperfect and asymmetric information

*Explain the risks of the project*

*Explain the difficulty to access to market finance*

*Explain the difficulty to recruit*

* + 1. Technological risk

The European Commission generally recognizes that a greater technicality of a R&D project goes along with a greater probability of failure. R&D and innovation are highly complex and challenging in the telecommunications sector, and therefore they inherently carry a very high level of risk.

In the specific context of the IPCEI on Microelectronics, DT will undertake RDI activities in order to explore the compatibility of different parts of the O-RAN network, where the technological paths are very risky. DT is focusing on developing numerous components which would holistically be able to affect the scale of competition, instead of players competing on the whole network provision, there would be competition on each component of the network.

It is well understood that all these very innovative R&D and innovation pathways that will be explored as part of the IPCEI on Microelectronics may not be performing as anticipated. The technologies developed by DT are characterized by a very high level of complexity and there is a high risk that the work undertaken in the project will not achieve all the expected results, or not in the anticipated planning. For each technical objective, there are indeed several paths that can be explored in parallel, and the paths chosen within the project may not produce the expected performances.

Furthermore, there is a risk of non-compatibility of the solutions developed in IPCEI on Microelectronics in FID and large-scale industrialization or with the equipment available on the market. High-performance technology may be difficult to exploit in order to produce operational finished products. For example…

The technological risks are essentially linked to technical issues that can occur during the project. The technological risks are considered by DT as exceeding the level of risks usually observed in more standard developments. A large number of potentially cumulative technological hazards could quickly lead to an unacceptable failure in performance which could require unforeseen additional work (studies, modifications, tests) in order to reach the initial objective, hence leading to significant delays and additional costs.

* + 1. Economic risk

Regarding the economic risks, the technologies developed under the IPCEI on Microelectronics are positioned upstream of the products that will could ultimately be marketed by DT. Therefore, the risk is very high that DT would not be able to exploit commercially as expected the results of the project.

In particular, given learning curves in competing technologies for…

* + 1. Partnership risk

The risk of partnership of a very large R&D program such as the IPCEI on Microelectronics results from the difficulties to organize the coordination and the synergies between such a large number of actors and centers of competences that are culturally very different, as well as to maintain the cohesion of the partnership in the long run.

The R&D partnership set up in the project IPCEI on Microelectronics involves a very large number of partners coming from various sectors, they also have different sizes and institutional origins. Indeed, the IPCEI on Microelectronics requires academic research laboratories and companies to work together on common scientific and technological objectives. Given the strong interdependence between their activities, it will be very difficult to coordinate their numerous contributions to the project. It is clearly the case regarding the contributions of the numerous public research laboratories, which will work in parallel on multiple tasks of scientific modelling and development of basic technological building block.

* + 1. Risk associated with major R&D programs

Major R&D programs such as IPCEI on Microelectronics, which extend over several years and aim at many technological breakthroughs, are generally exposed to numerous and significant risks that are not all identified and even less quantified. For example, it is common for nominal objectives not to be achieved, also there may be defects at the interfaces, delays in the availability of the results of a subsystem, failures of partners during the program, technical and functional problems, etc. This is why significant uncertainty often weighs on the respect of the initial schedule, as well as on the forecasted estimation of R&D and FID expenditures. The two risks are associated to the extent that each year of delay generally induces significant additional costs.

Moreover, it is reasonable to consider that the more elementary building block are included in the objectives of the program, the more these risks intensify and the chances of failure multiply exponentially. In the IPCEI on Microelectronics, DT plans to work on several technological building blocks, as well as on their integration, which has an adverse impact on its chances of success.

* + 1. Regulatory risk

European regulations such as the RoHS directive prohibit the use of certain components, and the REACH regulation requires the registration and evaluation of any new chemical used. European regulations introduce regulatory constraints for European manufacturers that have not, or not yet, been imposed to their Asian or American competitors.

These regulations apply in particular to manufacturing processes that use substances banned only in Europe, which may limit the operation of European factories. For the purposes of the IPCEI on Microelectronics, it is important to focus attention to comply with these European regulations, which are often more stringent than those in force in the United States and Asia.

Complying with such regulations may have severe consequences on FID investments by increasing the costs and slowing down the industrialization process from a competitive point of view.

* + 1. Strategic and organizational risk

The strategic and organizational risks are those associated with DT strategic dependence on a specific sector, i.e.example. They also include the risks associated with the availability of raw materials, especially needle and regular pet coke, potential market power of one or more of DT customers, the geopolitical risk in the manufacturing of XX components or the mastering of the technologies and their ecosystems.

* + 1. Difficulty to recruit highly qualified personnel

At global level, the telecommunications sector suffers from an important difficulty for the recruitment of highly qualified profiles, a problem that hinders the development and commercialization of innovative technologies. This shortage is a result of mismatches between needed skills and available skills on the labor market. The qualifications proposed by the education system, university formations or training programs lag behind the fast-changing specific highly qualified profiles required in the telecommunications sector. This problem is well documented in numerous studies, reports and research publications.

One key problem is that training programs fail to include several scientific disciplines under one technological field, while companies in the telecommunications sector are demanding profiles with strong interdisciplinary skills.

One of the main objectives of the public support for the IPCEI on Microelectronics is precisely to foster university – industry collaboration and to enhance the attractiveness of the European batteries clusters regarding the highly qualified labor market, thus supporting the evolution of academia to train and supply to the market these highly qualified profiles. For that purpose, thanks to public funding, the IPCEI on Microelectronics will implement the following features at a very large European level: a strengthening of partnerships, a better circulation of ideas and people and a better mutual understanding between public research organizations and companies.

* + 1. Strategic independence of supply
  1. Adequacy of the state aid instrument

*Explain whether the state aid instrument is in adequacy to correct the market failure:*

* *Grant = coordination default and spill-over*
* *Financial instrument = Imperfect and asymmetric information*
* *Recoverable advance = risks taken in the project prior to marketing*
  + 1. Appropriateness among alternative policy instruments

There is no other less distortive policy instrument than State aid which would make it possible to achieve the same result for the IPCEI on Microelectronics.

* + - 1. The regulation

Regulation is a standard and widely used public policy instrument. The use of regulation to implement the IPCEI on Microelectronics has little practical consistency. In theory only, Member States could impose to companies in the industry to develop the innovations proposed in the IPCEI on telecommunications, based on full technical specifications. However, because of the numerous technological uncertainties weighing on the technological building blocks and integrated systems to be developed, such regulation does not seem to be realistic. For example, it is very likely that due to deficient information from the State regarding the evolution of the telecommunications market, regarding the technological state of the art, regarding the strategies of the different actors, etc., the choice to impose the development of such an innovation rather than another would be inefficient.

It is much more efficient to trust the strategies and technological choices of companies to decide on their R&D projects. This is the option retained in the IPCEI on Microelectronics.

* + - 1. A better funding of public research

The IPCEI on Microelectronics aims at removing technological barriers and demonstrating the technical and economic viability of many industrial innovations in the field of networks. The project must therefore have a strong technological and industrial component, on top of its scientific dimension. To this end, R&D activities must be carried out simultaneously in public research organizations (which will contribute, with their advanced knowledge, to the development of scientific models, generic technological building blocks,) and in companies, which have the essential role to ensure the development of new technologies and their industrial and commercial deployment. A very important gap (in terms of time, cost, and risk) separates the concepts studied in PROs from the demonstration of the technico-economic viability of an innovation, carried out in companies.

A better funding of public research would not achieve the same effect as the State aid from France for the IPCEI on Microelectronics, meaning the structuration of a sustainable ecosystem of research and innovation around a very large R&D partnership between many public and private actors from numerous EU Member States.

* + 1. Appropriateness among different State aid instruments

In the context of the IPCEI on Microelectronics, the main market and systemic failures come from spillovers, coordination problems and Europe’s strategic dependence. To address these failures, a grant is the most appropriate State aid instrument.

A public soft loan, a State guarantee or a repayable advance are not viable alternatives because the project does not have the required rate of return to make it attractive should such instruments be received.

The grant is intended to compensate for the low profitability of the project for DT without State aid, induced by the very high level of spillovers (see Section 3). It is well known in economic theory that such positive externality is corrected by granting a so-called Pigouvian subsidy to the economic agent who is at the origin of the externality, namely DT who carries out the R&D and FID activities which will benefit to third parties.

The simulation of a repayable advance in the business plan can only have a marginal impact on the project’s profitability: public money is received in the first hand but reimbursed including interests in the nominal scenario of success. Only a direct grant has the potential to have the profitability reach the company’s hurdle rate by filling the funding gap.

The payment of the grant also limits the potential financial losses of the partners in case of project failure, which reduces their incentives to opportunistically use contractual incompleteness to their advantage. Repayable advances have a major drawback in this respect: they provide an additional incentive to opportunistically use contractual incompleteness, since putting the project in a situation of failure from the contractual point of view makes it possible to avoid repayment of the advance (while the project could be a success from the technical and commercial point of view). The grant DT is therefore the appropriate aid instrument to address the coordination problems in IPCEI on Microelectronics.

However, the grant provided by Germany to DT could be backed upon a claw-back mechanism that shall be targeted on the FID activities and related costs / State aid (they are closest to the market).