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# Digitalisation as threat to resilience: what if there are no more semiconductors?

Ludmila Courtillat--Piazza\*

Sophie Quinton†

Clément Marquet‡

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Digitalisation is often seen in Europe as a major driver of transition towards a more sustainable world<sup>1</sup> [8–10]. In reaction to this, some researchers in computer science and electronics argue that the ecological benefits of the so called digital solutions are unclear, and highlight their negative impacts on the environment [4, 17]. Others voices, working in Science and Technology Studies (STS) and geography, call out the social injustice and neo-colonialism that are closely linked to the ICT industry and research: armed conflicts related to extractivism [14], traffic of e-waste from the global North to the global South [3], precarious digital labour [5]. A third aspect of the issues raised by the ubiquitous digitalisation of Europe is resilience, which is the topic of this position paper.

Resilience has been studied by many research communities [13, 16, 21]. It can be defined as the ability of a system to absorb and resist adverse events, quickly recover from failure and evolve in front of a changing environment. Making our societies resilient is part of the transition towards sustainability [12].

In the ICT domain, resilience mainly focuses on facing internal faults, malicious attacks and natural disasters [18, 21]. Resilience analysis in ICT includes many aspects such as *fault tolerance*, *dependability* and *security* [21]. There seems to be, however, little work on the relation between the resilience of ICT infrastructure and the resilience of our societies in a future more and more constrained by planetary boundaries and its consequences on our social organisations. Recent work addresses the resilience of ICT infrastructures in front of natural disasters amplified by climate change [1, 23]. Other issues remain to be explored by ICT communities. As an example, we will focus on the resilience of ICT under a limited access to semiconductors.

The semiconductor manufacturing industry is dominated by countries located in South-East Asia, in particular Taiwan, and relies on a very complex supply chain [19]. In 2021, a severe drought in Taiwan, combined with other Covid-related factors, resulted in a global semiconductor shortage with wide economic consequences [22]. This past experience hints at how a long-term and larger scale semiconductor shortage, e.g., due to a natural disaster in Taiwan, a critical raw material shortage or a geopolitical crisis between actors of the supply chain,

could impact the whole economy. This issue has been acknowledged by the European Commission with the Chip Act [6] and the Critical Raw Materials Act [7].

From a resilience perspective, digitalisation policies in Europe can be seen as violating various resilience principles<sup>2</sup> among those listed in [21]. As an example, the ubiquity of ICT in all sectors of society — including electricity power control, communication and mobility [2, 6] — results in a lack of diversity (P12), defined as providing alternatives so that even when challenges impact particular alternatives, other alternatives prevent degradation from normal operations<sup>3</sup>.

Based on the previous development, we seek to study the resilience of ICT under long term limitations on semiconductor availability. As a starting point, we focus on mobile networks. What would be the consequences for mobile networks of a long term semiconductor shortage leading to the nonreplacement of ageing hardware? What level of quality of service could be maintained and for how long? What network guarantees would we need to ensure the resilience of our societies? These questions require a systemic approach to better understand the social implications, for example in terms of equity, of different levels of quality of service and resilience of ICT networks.

Note that research on this topic can also be useful to build or assess strategies to restrict the use of semiconductors in order to reduce the associated environmental consequences, or Europe’s dependency on neo-colonial industries for example. More generally, our research addresses two questions: What can be done with the infrastructures we already have? To what extent must we reduce and transform our reliance on it if we cannot or do not want to replace ageing infrastructures? We aim at combining mobile network modeling and evaluation tools with STS methods such as sociological survey to address this questions.

In conclusion, we believe that addressing resilience issues is complementary with studying environmental impacts and social injustice to underline the risks and drawbacks of ubiquitous digitalisation. Investigating ICT resilience and its consequences under long-term semiconductor scarcity is one example of the type of research the ICT community could tackle, especially when dealing with critical applications (health, electricity power control...).

\*LTCI, Telecom Paris, Institut Polytechnique de Paris, Palaiseau, France

†Univ. Grenoble Alpes, INRIA, CNRS, Grenoble INP, LIG, Grenoble, France

‡Centre de Sociologie de l’Innovation, Mines Paris - PSL, Paris, France

<sup>1</sup>About sustainability, see e.g. the *strong sustainability* notion as explained in [11] and the planetary boundaries framework [20].

<sup>2</sup>For example *diversity* (P12), *complexity management* (P7), *normal behaviour knowledge* (P2) and *evolvability* (P17).

<sup>3</sup>Besides, dependency on ICT in most cases also means dependency on big tech companies such as Google, Microsoft and Meta, which dominate the everyday services used by the majority of the population [15]. This also represents a lack of diversity.

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