Technology Transfer in Computing Systems: The TETRACOM Approach

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***Abstract*—TETRACOM is an ongoing EU FP7 Coordination Action with the ambition to boost small to medium scale academia-to-industry technology transfer in all domains of computing systems. The project primarily operates via competitive open calls for individual *Technology Transfer Projects* (TTPs). Each TTP performs a well-defined bilateral transfer activity between one European academic partner and one industry partner. TETRACOM coordinates all TTPs and provides technology transfer advice and co-funding. This paper describes TETRACOM´s experimental concept and project structure. It summarizes preliminary lessons learned after more than two project years and successful management of 30+ individual TTPs.**

Keywords—technology transfer

I. TETRACOM MOTIVATION AND ORIGIN

The following definition comes close to TETRACOM´s notion of technology transfer:

"Technology transfer … refers to the formal licensing of technology to third parties, under the guidance of professionals employed by universities, research foundations and businesses, in departments focused on these activities." [An Inventor's Guide to Technology Transfer, Massachusetts Institute of Technology (MIT)]

TETRACOM is partially rooted in HiPEAC, a strategic European Network of Excellence in computing systems (www.hipeac.net). In 2011, HiPEAC initiated an expert roundtable to discuss new avenues in European technology transfer from academia to industry. The European Commission has very high expectations on industrial impact of funded R&D projects, in particular within the new Horizon 2020 framework. Unfortunately, the flow of new technologies from EU R&D projects into industrial innovations and products is still far from optimal. It was concluded that *technology transfer (TT)* in computing systems could be improved in various ways:

Establish realistic TT marketplaces: Given the structure and dynamics of typical EU collaboration projects it might be unrealistic to expect that some project delivers innovation as a whole and right at the end of the project. Naturally project proposals contain "exploitation plans" written with good intentions, but these plans are rarely in the focus during the project duration, and finally tend to be neglected when the project fades out. Obviously there are a few notable examples where an EU R&D project in its entirety "exited" into a new business. However, as a consequence of the scientific dimension of R&D and its inherent risk, it is more realistic to assume that the "average project" generates high-potential technology or even breakthroughs in some fields while it fails in others. Thus, the main TT potential is centered in some specialized, individual technologies or IPs, for which a relatively small base of worldwide potential adopters exist. Moreover, the TT market is quite ad-hoc, and the adopter of a newly developed technology might be spatially and/or temporally disconnected from the original R&D project and its consortium. This motivates the organization of *TT marketplaces* which provide a forum for balancing TT supply and demand, disseminating best practices and, most important, to provide incentives for actually making TT happen, given the associated overhead. TETRACOM can be seen as organizer, moderator, and sponsor of such a marketplace.

Select the right TT granularity and volume: Especially in academia, TT is often misconceived as necessarily generating sustainable business and continuous growth via spin-off or start-up companies. In fact, there is great wealth of start-up oriented entrepreneurial programs, workshops, trainings, awards, and the like at national and EU level. While such initiatives are definitely inspiring and useful, their success rate is limited: For instance, the underlying technology might have a too small target market, there might be no adequate founding team, or necessary venture capital investments cannot be acquired. In such a situation, a more promising approach is enabled via customized bilateral TT: An academic provider transfers a specific IP or technology (e.g. a software tool or a hardware IP block) to an industrial receiver, who intends to utilize this technology within new or improved products or processes. The two partners enter into an agreement that precisely defines the TT contents, duration, and

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how to bridge the TRL gap, while also covering IPR and legal issues and a fair compensation to the technology provider. In fact, TETRACOM´s major instrument, the *Technology Transfer Projects* (TTPs, as described in section III), is designed to precisely serve such a scenario.

In 2013, after several refinement rounds and further expert consultations, TETRACOM was launched as an official EU FP7 project with the mission to implement the above ideas for improved and more effective TT. The purpose of this paper is to outline how such an experimental TT-oriented "pilot project" can be conceived and to provide an intermediate status report with preliminary dos and don'ts.

II. PROJECT STRUCTURE

Formally, TETRACOM is an EU FP7 Coordination Action with duration of three years (Sep 2013- Aug 2016) and a budget of approx. 2 Mio. Euros. The project consortium consists of eight "founding partners", which also form the Steering Committee, as well as a number of more loosely connected "TTP partners", which accumulate over the different rounds of open TTP calls. The project is structured into four work packages (WPs):

1) Competitive open calls for TTP proposals: TETRACOM targets the entire European computing systems community. The project issued three open calls for TTP proposals and distributed them via different channels, e.g. the HiPEAC mailing list, as well as via numerous public events. Since the co-funding level for individual TTPs is relatively low (typically 10-50k Euros), *the submission and evaluation scheme is kept very efficient and lightweight*: Each call is open for 6 weeks, proposals are limited to 3 pages, and evaluation takes 6 weeks maximum, too. In total, TETRACOM spends approx. 1.3 Mio. Euros on TTPs.

2) Infrastructures for stimulating new TT: Next to usual infrastructure facilities (e.g. project web site, social media, and regular newsletters), this WP comprises a *Central Help Desk* for "TT newcomers" and generally all proposers seeking advice on maximizing their TTP proposal quality. Moreover, TETRACOM runs a series of successful *TT workshops*, often co-located with major European computing events like DATE or the HiPEAC conference.

3) Individual TTPs: This WP is merely a "container" for hosting all individual TTPs. It has been conceived to match the relatively static FP7 project rules with the high dynamics implied by the TETRACOM concept.

4) Project management: This WP comprises the usual strategic and day-to-day management facilities. Moreover, TETRACOM relies on the feedback of a high-profile *Industrial Advisory Board*, which partially compensates for the fact, that by construction the TETRACOM consortium deliberately does not include any non-academic partners.

III. THE TTP CONCEPT

Individual *Technology Transfer Projects* (TTPs, Fig. 1) constitute the core instrument of TETRACOM. The TTP concept originates from typical bilateral academia-industry collaboration scenarios in the domain of computing systems: A research entity R has developed a certain technology or IP for solving a technical problem, often within a publicly funded project. Some company C has a similar problem in their current R&D activities and gets interested in R´s general solution approach. The requirements are analyzed in detail, and as a result R and C may sign a bilateral R&D or license agreement to make the technology available to C under certain conditions and for an appropriate compensation. In most cases this requires R to perform additional services, usually under tight timing constraints, around the licensed technology to actually bridge the TRL gap between the original prototype and a working solution for C, and in order to provide the required technology support and training.

Figure 1: Bilateral technology transfer via TTPs

In order to make this concept sufficiently concrete within a formal EU project context, the following *rules for TTPs* were defined:

There are two partners involved: One partner has to be from a publicly funded research entity (typically a university or polytechnic), the other one has to be privately funded (i.e. typically a company). This reflects the most frequent TT scenario, where the two-partner scheme guarantees focus, confidentiality, and exclusivity.

The two partners have signed a bilateral legal agreement to perform a certain TT activity: TETRACOM does not get involved (and even cannot be normally due to confidentiality reasons) in negotiations of these individual agreements. The agreement merely serves as a proof that the TT is actually intended or taking place, since the agreement has passed all internal legal hurdles of the TTP partners.

The total project duration is between 3-12 months: Due to the tight industrial schedules, academia-industry collaboration on a concrete TTP rarely takes more than a year. If a TTP only focuses on licensing

of a specific existing technology, its duration can also be very short. However, TETRACOM assumes that a basic level of service and training is always involved, which leads to the minimum duration of 3 months.

The total project budget is between 20k-200k Euros: The lower bound is intended to neglect low-volume "mini TTPs" and to focus on projects with some critical mass. The upper bound is motivated by the fact that partial TTP funding (up to a certain percentage) via TETRACOM is naturally limited by its total budget. TETRACOM sponsors granted TTPs with up to 50%, i.e. 10k-100k Euros. *This contribution is paid only to the (academic) research partner of a TTP*, since the industry partner will indirectly benefit from the TTP by construction.

Many sample TTPs are described on the project home page www.tetracom.eu. Following TTP proposal submission within the regular open calls, all proposals are externally evaluated by at least one academic and one industrial reviewer. The *evaluation criteria* are as follows:

TTP impact: To what extent will the proposed TTP lead to added value according to the following?

- Probability of scientific publications
- Probability of a resulting start-up foundation (if applicable)
- Number of users inside the company
- Quality improvement of products and processes (e.g. efficiency, performance, power consumption)
- Potential for subsequent sustainable partnership
- Potential for enabling new products

Soundness of TTP concept: Are the proposed TTP concept and its associated work plan realistic within the given budget and time frame?

Quality of the research/industry partner combination: Is it likely that the proposed combination will succeed in its TT goals, given the academic and business profiles of the two partners?

Resources: Are the proposed resources sufficient and well justified altogether? Is the industry partner´s contribution sufficiently significant to substantiate his interest in the proposed TTP? TETRACOM requires that *the industry partner contributes at least 50% of the total project budget*.

The evaluation leads to a ranking of submitted TTP proposals, where the score on impact has highest weight. In case of ties, some secondary criteria apply, e.g. a The Steering Committee fine-tunes the ranking list according to necessities and grants TTPs until the respective call budget is exhausted. Afterwards, all TTPs of a given call are synchronously kicked off, are performed locally by the partners with minor TETRACOM interaction, and finally deliver an abstract and an impact report after project conclusion.

IV. PRELIMINARY RESULTS AND OBSERVATIONS

While TETRACOM has also organized numerous well-attended infrastructure events (e.g. TT workshops), *we focus on the results of the TTPs here*, which form the most novel and experimental part of the project. TETRACOM currently runs, or has completed, 33 individual TTPs. Out of these, 11 are performed by the founding partners, while 22 were granted to third parties after the first two open TTP calls. Another 12-14 TTPs are expected to be granted around Nov/Dec 2015 after the third and final open call. Thus, altogether, TETRACOM will meet its initial goal of coordinating up to 50 TTPs in total.

The first two open calls received 74 TTP proposals, resulting in a total acceptance rate of 30%. The average co-funding of TTPs by TETRACOM is around 25k Euros, but there is considerable variance. Some further key statistics are summarized in the table below. More information is available via the project web site or the public TETRACOM deliverables.

	Call 1	**Call 2**
Submissions	31	43
Countries involved	13	12
SME involvement	45%	74%
Proposals from new EU member states	3	9
Average requested funding (EUR)	30,000	28,000
Average matching industry funding (EUR)	27,000	32,000
Average TTP duration (months)	9	9

In May 2015, a first systematic impact analysis has been conducted on the basis of 8 TTPs already concluded at that time. The analysis showed already quite considerable and tangible project outcomes. All finished TTPs delivered a comprehensive impact questionnaire for this purpose. The most concrete findings were as follows:

- The TTPs contributed to 6 *publications* in international journals and conferences.
- 14 TTP-specific *presentations* at workshops or trade shows took place.
- 1 TTP result will be donated as an *open source* tool.
- 2 TTP-related *patent applications* have been filed.
- Most TTPs delivered new professional or educational *training* activities and materials.
- There were already 2 very concrete cases of TTP-related technology adoption by the company

partner in the form of *new products*. 4 company partners reported internal *process improvements*.

- 2 TTPs reported an immediate impact on *sales projections* and VC *investment acquisition*.
- 4 *additional jobs* have been created with the TTPs´ industry partners.
- All TTPs reported improved opportunities for *sustainable academia-industry partnerships*, e.g. in the form of follow-up TTP proposals or other grant applications.
- 4 TTPs traced back their project to a previous or ongoing *publicly funded research grant*.
- All TTPs reported a *TRL elevation* by 2 levels.

Further impact evaluations will be performed towards the project end, based on a much larger set of completed TTPs by then. For now, the following *intermediate conclusions* can be drawn:

What works well:

TT marketplace concept: The great community response to the open TTP calls indicates that there is indeed a significant market for computing systems TT in Europe. TETRACOM provides a platform for boosting and structuring it. Via its infrastructures, like TT workshops, presentations, and individual consulting, TETRACOM stimulates very concrete TT activities and helps to actually implement them by providing a monetary incentive.

TTP concept: TETRACOM deliberately does not support long-term R&D activities with uncertain outcomes. These are left to the "traditional" R&D project instruments. Instead, all TTPs must have a precise focus in order to maximize the industrial impact. The TTP concept enforces this by the strict two-partner scheme, relatively short project durations, and the fact that all TTPs must revolve around the transfer of some pre-existing IP.

Proposal handling: Given the limited average TTP funding of 25-30k Euros at a 30% acceptance rate, proposers obviously cannot be asked to submit complex, lengthy proposals with all the usual bells and whistles. Likewise, the "time-to-transfer" has to be very short in order to meet the TT market dynamism and ad-hoc opportunities. TETRACOM TTP calls are open for 6 weeks, proposals are limited to 3 pages, and successful proposers can begin with their TTP after another 6 weeks of review and granting procedures. The formal accession to the consortium is largely handled "offline".

What could be improved:

TTP profile definition: Due to the novelty of the concept, some setup time was required to clearly communicate the structure and constraints of "desired" TTP proposals. For instance, this concerns the precise definition of "academic" and "industry" partners (there are entities in between) as well as the fact that a TTP needs to be more than just yet another "mini R&D project". The optimal "embedding" of a TTP into an ongoing longer-term academia-industry collaboration contract has also been an issue on various occasions. Another observation is that the project could benefit from a clearer thematic focus. Since TETRACOM currently addresses TT in virtually all domains of computing, the individual TTP topics are quite scattered. More impact might be achieved via TETRACOM-like projects that only focus on e.g. low power, HPC, embedded SW design, chip design etc.

Inter-TTP synergies: Once granted, TTPs run more or less freely to their conclusion at the two partners´ sites. TETRACOM mostly plays an administrative and observer role in this phase. Currently, there is no instrument yet for systematically monitoring possible synergies and suggesting corrective actions to the TTP partners. Therefore, some impact opportunities might be missed. Moreover, a sharper thematic profile, as mentioned above, would also help to implement synergetic TTP structures.

Formal TTP administration: Under FP7 rules, TTP partners have to join the project consortium, which implies considerable administrative effort. TETRACOM aims at hiding this as much as possible from the TTP partners, but simplification is certainly desirable. The new H2020 concept of "third party funding" will probably help in this respect. Moreover, the EU funding rules usually imply that at most 50% of the total project budget can be spent by any form of "unknown" partners. This unnecessarily limits the flexibility in the highly dynamic domain of individual TT, and a larger maximum percentage should be permitted for sake of higher efficacy.

Impact measurement: "Impact" is a key concern today in all EU projects, so TETRACOM spent considerable effort on the definition of its optimal impact criteria. Some of them are quite precise and numerical (e.g. publications, revenue increase, or new jobs created), while other ones are "softer", such as TRL or sustainability. More effort is needed (actually for all EU R&D activities) to further optimize the preciseness of the impact metrics. Another concern is that much impact is only manifested after longer time periods, e.g. when TT results are turned into a new industrial product, which often requires passing many time-consuming hurdles. The impact measured for TETRACOM TTPs should partially be attributed to their foregoing R&D projects. Likewise, TETRACOM cannot measure TTP impact beyond its project duration. Thus, fairer and more long-term impact measurement techniques should be conceived.