



# MULTIPLY Research and Training Framework



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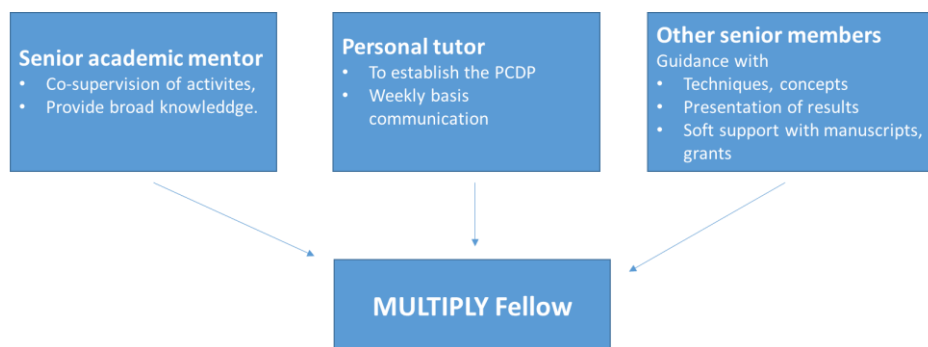
## 1. Introduction

This document is aimed at assisting you in the preparation of sections of the MULTIPLY proposal pertaining to research, training, dissemination and career development objectives.

The primary objective of MULTIPLY is to provide the fellows with a range of interdisciplinary research skills, transferable complementary skills, research knowledge, and industrial experience necessary to develop the next generation of photonic components and systems for optical networks, lasers, and a wide range of photonic devices targeting bio- and medical applications, nano-photonics, telecommunication, and sensing applications. Training will be implemented through **Individual training schemes**, and **Programme-wide training activities**.

## 2. Individual Training Schemes

### 2.1 MULTIPLY Tutelage Framework



Every fellow will have a designated **senior academic mentor**, as well as a **personal tutor** (a supervising academic), both of whom will play an important role in day-to-day technical interactions.

The **mentor**, along with the **personal tutor** will supervise the scientific work and the international links of the fellow within the MULTIPLY programme to provide broad knowledge of photonics and its applications across different sectors.

The fellow and tutor will be required to communicate face-to-face on a weekly basis to discuss and review the progress of the fellow's work.

A central task of the **tutor** will be to establish in consultation with the fellow their Personal Career Development Plan (as a part of Research Project and Training Plan).

In addition to the mentor and tutor, each host group has several **senior members** who will aid the training by providing: i) training in specialised techniques or research concepts; ii) guidance and support in the presentation and communication of data; iii) full support in preparation of manuscripts and grant applications.

### 2.2 Personal Career Development Plan

The Personal Career Development Plan (PCDP) will include the individual's tailored training needs and career moves. It will define

- Academic mentor, tutor, senior member roles
- Research and training activities (see Training deliverables)



- Collaborative visits to other MULTIPLY Partners
- Attendance at training courses, conferences

Further, it will also help identify opportunities for the fellow's future career. A generic PCDP template has been provided on the MULTIPLY website as a starting point. You are welcome to use existing internal templates, provided they cover the items indicated in the generic one.

### 2.3 MULTIPLY Training Deliverables

MULTIPLY fellows may come from a variety of educational backgrounds: from theoretical and experimental physics to computer science and telecommunications, and from biomedical engineering and biology to mathematical science. Regardless of their background, the fellows will have the opportunity to participate in the courses and training provided in the 5 main scientific areas and thus will develop broad general expertise in the domains of nonlinear optics, digital signal processing, network design and management, sensing and biomedical imaging, statistical physics, material science, RF-engineering, opto-mechanics, but they will acquire specialised and detailed training in at least one domain. We envisage two kinds of training deliverables in the photonics discipline and the relevant research areas: **Research Knowledge** (RK — covering broad scientific knowledge) and **Scientific Research Skills** (SRS — covering more specific experimental and theoretical methods and techniques).

In addition to the core scientific training, professional complementary training on entrepreneurial activities, research commercialisation and teaching techniques, communication, public outreach, management, grant writing, IP and career development will be organised both within the MULTIPLY host organisations and at the all-MULTIPLY workshops and Summer School. The training will result in better understanding of industrial requirements, specifications, and trends and, therefore, will be also beneficial for the fellow's career. These will form the following training deliverables in **complementary (research-oriented) transferrable skills** (CS).

The individually tailored PCDP for the fellows should include references to these training deliverables, and how these would be achieved. In conjunction with the fellow's supervisor progress in delivering these skills will be monitored by and reported to the MULTIPLY Programme Co-ordination Team in annual intervals at a minimum.

[Appendix 1](#) gives details of the RK, SRS, and CS training deliverables. [Appendix 2](#) suggests how existing training frameworks within the host institution can contribute towards these training deliverables.

### 3. Programme Wide Training Activities

MULTIPLY will organize 5 workshops, 2 summer schools, and subject-focused flexible training events. The five MULTIPLY workshops will address: (1) Challenges in optical communications, (2) Laser science and technology, (3) Bio-medical photonics, (4) Nano- and integrated photonics, (5) Emerging applications of photonics. Two all-programme summer events are planned: (1) Summer School on photonic technologies and applications and (2) Summer School on future photonic technologies where the world-leading academics and industry representatives will be invited to give lectures. MULTIPLY members have considerable collective experience in organising such events. These events will provide to fellows training of complementary skills, not available to each individual fellow in their host laboratory, thus broadening their methodological base. Workshops will last between 2 days and 1 week, Summer Schools will last at least 4 days.



## Appendix 1

### MULTIPLY Training Deliverables

**Research Knowledge (RK)** will be attained via host institutional MSc programmes, with specified modules/workshops provided to strengthen the scientific background of the researchers. They will include themes on optical networking, advanced fibre-optic technologies, fibre laser science and technology, including random lasers, biological and medical applications of lasers, fabrication and characterisation of photonics components and systems in the context of application in high-capacity communication and sensing.

<i>Scientific Research Skills (SRS)</i>		<i>Complementary Skills (CS)</i>	
SRS 1	Non-linear fibre optics;	CS1	Cultural diversity;
SRS 2	Digital signal processing;	CS2	Language;
SRS 3	Network control and management;	CS3	Research commercialisation;
SRS 4	Optical network optimisation algorithms;	CS4	Public outreach;
SRS 5	High-speed RF electronics;	CS5	Presentation & communication skills;
SRS 6	Photonic subsystem development;	CS6	Entrepreneurial skills;
SRS 7	Fourier optics;	CS7	Career development (such as curriculum vitae construction, interview techniques, etc.);
SRS 8	Photonic integration;	CS8	Supervisory skills;
SRS 9	Component packaging;	CS9	Organization;
SRS 10	Optical network communication test-beds and measurements techniques;	CS10	Networking;
SRS 11	Non-linear wave dynamics;	CS11	Financial management;
SRS 12	Material science;	CS12	Project management;
SRS 13	Imaging;	CS13	Paper/patent/proposal writing;
SRS 14	Sensing;	CS14	Meeting/board skills
SRS 15	Medical lasers;	CS15.	Team-working
SRS 16	Light-matter interactions;		
SRS 17	Disordered systems;		
SRS 18	Optomechanics.		



Over and above the training at the respective host institutions, the MULTIPLY Workshops will aim to contribute towards the above training deliverables in the following fashion:

<b>Workshop</b>	<b>Deliverables</b>
Challenges in optical communications	SRS1-6, SRS10
Laser science and technology	SRS1,SRS7, SRS11,SRS13-18
Bio-medical photonics	SRS1-3,SRS6,SRS8-9,SRS11-18
Nano-and integrated photonics	SRS1-2,SRS5-12, SRS14,SRS16-18
Emerging applications of photonics	SRS1-18



## Appendix 2

### Existing institutional training programmes contributing towards MULTIPLY training deliverables

The following are some suggestions towards utilizing existing training programmes and other activities within the host institution for contributing towards the MULTIPLY training deliverables.

- **Attending core-curriculum classes, masterclasses, crash-courses (RK,SRS)**  
*At the time of framing the PCDP, the mentor/tutor can make the fellow aware of such possibilities.*
- **Attending career development seminars (CS3,5-12,14,15)**
- **Attending internal seminars (RK,SRS1-18)**
- **Organizing seminars/workshops/conferences (CS9-12,14)**
- **Teaching (CS7-9)**
- **Giving internal seminars (CS5,SRS)**
- **Writing papers/grants/patents (CS3,13)**
- **Reviewing papers/grants/patents (CS3,13)**
- **Outreach activities (CS4,15)**
- **Language classes (CS1)**