TECHNICAL REVIEW REPORT

Information and Communication Technologies
ICT

Project acronym:	NAVOLCHI
Project title:	Nano Scale Disruptive Silicon-Plasmonic Platform for Chip-to-Chip Interconnection
Grant agreement number:	288869
Funding scheme:	STREP
Project starting date:	01/11/2011
Project duration:	45 months
Coordinator:	KIT – Karlsruhe Institute of Technology
Project web site:	www.navolchi.eu

Period covered by the report:	Period No. 2 (from 01/05/2013 to 05/11/2014) *(Review no. 3 - intermediate review in the period)*
Place of review meeting:	Brussels
Date of review meeting:	05/11/2014
Experts:	Andrew Shields, Toshiba Research Europe, Cambridge Raimondas Petruskevicius, Center for Physical Sciences and Technology, Vilnius
Project officer:	Michael Hohenbichler

Report version:	2
Report date:	23/02/2015

Individual report	☐
Consolidated report	☒

SEVENTH FRAMEWORK PROGRAMME

European Commission
Information Society and Media

1. OVERALL ASSESSMENT

a. Executive summary

Please give your overall assessment of the project, commenting on the following:
- *main scientific/technological achievements of the project*
- *quality of the results*
- *attainment of the objectives and milestones for the period*
- *adherence to the workplan, any deviations (whether justified) and remedies (whether acceptable)*
- *take-up of the recommendations from the previous review (if applicable)*
- *contribution to the state of the art*
- *use of resources*
- *impact*

The strategic objective (enabling a high-bandwidth / low power / small footprint chip-to-chip interconnect, integrated on silicon) remains of high importance for future CMOS electronics. The NAVOLCHI approach promises, in the long term, clear advantages to more conventional optical or electrical interconnect solutions by combining their respective advantages, i.e. the small footprint of electronics with the high throughput / low power / short transmission delay of optical solutions.

The project has ambitious overall objectives of realising a suite of plasmonic devices with potential application in optical interconnects, such as lasers, modulators, amplifiers and detectors, and furthermore to implement these components in an interconnect demonstrator.

During the assessment period plasmonic modulators have been realised with attractive characteristics and show considerable potential for implementation in the demonstrator. Progress has also been made for the other devices, although this has been somewhat slower than anticipated. Nevertheless, there is optimism that a successful conclusion can be reached during the extension period. Processing problems for the metallo-dielectric nanolaser have been overcome, allowing an attempt at the full device structure in the remaining months.

The development of the plasmonic receiver devices (amplifier and detector) lags behind that of the transmitter devices and at this point it is not clear if they can progress sufficiently to be included in the demonstrator systems. Despite this there has been interesting and valuable progress on the amplifier and detector, especially on the synthesis and gain characterisation of HgTe quantum dots, that is promising for their future utilisation.

In the original plan, ST had the important role in WP6 of implementing a demonstrator of a plasmonic interconnect. Unfortunately a reorganisation at ST has meant that they have withdrawn from this role before any significant progress could be made. ETH Zurich has joined the project and is now undertaking work on the demonstrator. There has been a reallocation of part of the budget associated with WP6 from ST to ETH, which has been agreed by the EC.

Given the retreat of ST from the project, as well as the delay in progress with some of the technical deliverables, the project has been granted an extension of 9 months, and some deliverables and milestones are delayed accordingly. The project team have a realistic plan for the remaining duration of the project and may reasonably expect to achieve many of the original objectives.

b. Recommendations concerning the period under review

Please give your recommendations on the acceptance or rejection of resources, work done and required corrective actions – e.g., resubmission of reports or deliverables, further justifications, etc.

There are no recommendations concerning the period under review.

c. Recommendations concerning future work

Please give your recommendations – e.g., overall modifications, corrective actions at WP level, re-tuning of the objectives to optimise the impact or to keep up with the state of the art, better use of resources, re-focusing, etc. Where appropriate, indicate the timescale for implementation.

1. Submit at month 40/41 an additional milestone report (MS50) on the final planning of system demonstrators based on progress in devices.
2. Report also on the new enhanced metal grating couplers, for which no deliverable has been planned. This could be included in the new milestone MS51.

The following short-term recommendations from the review meeting were already complied with before the end of the review:

3. Submit a list of the planned deliverable and milestone updates *[Received – OK]*.
4. Submit a revised version of the 'innovation questionnaire' focussed on more specific results with promising innovations potential *[Received – OK]*

d. Assessment

☐ Excellent progress (the project has fully achieved its objectives and technical goals for the period and has even exceeded expectations).

X Good progress (the project has achieved most of its objectives and technical goals for the period with relatively minor deviations).

☐ Acceptable progress (the project has achieved some of its objectives; however, corrective action will be required).

☐ Unsatisfactory progress (the project has failed to achieve key objectives and/or is not at all on schedule).

2. OBJECTIVES and WORKPLAN

a. Progress towards project objectives

Assess to what extent the objectives of the project for the period have been achieved. In particular, please indicate if the project as a whole has been making satisfactory progress in relation to the Description of Work (Annex I to the grant agreement) and comment on the interaction between the work packages and the level of integration demonstrated.

The project has ambitious overall objectives of realising a suite of plasmonic devices with potential applications in optical interconnects, such as lasers, modulators, amplifiers and detectors, and furthermore to implement these components in a system demonstrator. During the assessment period plasmonic modulators have been realised with attractive characteristics and show considerable potential for implementation in the demonstrator. Good progress has been made for the other devices, although somewhat slower than anticipated. Nevertheless, there is optimism that a successful conclusion can be reached during the extension period.

In the original plan, ST had the important role in WP6 of implementing a demonstrator of a plasmonic interconnect. Unfortunately a reorganisation at ST has meant that they have withdrawn from this role before any significant progress was made. ETH Zurich has joined the project and is now undertaking work on the demonstrator. There has been a reallocation of part of the budget associated with WP6 from ST to ETH, which has been agreed by the EC.

Given the retreat of ST from the project, as well as the delay in progress with some of the technical deliverables, the project has been granted an extension of 9 months. The project team have a realistic plan for the remaining duration of the project and may reasonably expect to achieve any of the original objectives.

It is clear that partners have been working in an appropriate collaboration.

b. Progress in individual work packages

For each work package (WP), assess the progress in relation to the Description of Work (Annex I of the grant agreement). Please also report and comment on any delays, reasons for them and any remedial action taken. Specify the work packages concerned.

WP1: Management

The project is well managed. Regular face-to-face meetings and phone conferences (30 so far) have allowed good co-ordination of activities.

An intermediate progress report covering months 27-36 was compiled for the review and found to be of good quality. It would have been beneficial for the reviewers to have covered the entire period since the previous review meetings, ie months 18-36. However, a separate progress report for months 18-27 was available to the reviewers in the restricted area of the project website.

The deliverables and milestones have been compiled in a satisfactory fashion. Unfortunately the reviewers were not sent all the relevant deliverable and milestone documents before the review meeting. However, all the completed documents were available online.

The management team have negotiated an acceptable solution to the retreat of ST from the project. Juerg Leuthold's new group at ETH Zurich has taken over ST tasks in WP6.

WP2: Definitions and Specifications of Plasmonic Chip-to-Chip Interconnection Platform

Work in the WP has included a calculation of the expected system performance for several different combinations of components in the demonstrator (Task 2.2). Progress in this WP has been hampered to some extent by the fact that some of the individual devices (eg nanolaser, amplifier and plasmonic detector) are not yet available and so their performance characteristics are unclear. Nevertheless simulations have been made based on their expected performance.

Three different system implementations have been modelled
(i) direct modulation of the metallo-dielectric laser and a conventional photo-detector
(ii) the metallo-dielectric laser in dc mode and phase modulation using a MZM plasmonic modulator
(iii) off chip laser source and intensity modulation using a MZM plasmonic modulator.

The conclusion presented in the meeting is that scenario (i) will not give good acceptable bit error rates because of the low expected output power of the laser (40 microW). Using an off-chip conventional laser, scenario (iii) gives better results and appears the most realistic demonstrator. There appears to be some inconsistencies between the conclusions concerning use of the metallo-dielectric laser in the review meeting and the deliverable documents.

Tasks 2.3 and 2.4 are behind schedule and as a result there is a delay in the submission of deliverables 2.5 ("Techno-economical evaluation with respect to the cost efficiency and green aspects") and 2.6 ("Report on new applications and their opportunities") of WP2, discussed below.

WP3: Plasmonic Transmitter

Although a full working device has not yet been achieved, there has been good progress in fabrication of the metallo-dielectric nanolaser. In particular the III-V nanolaser has now been fabricated on top of a Si substrate. Progress has been made on issues associated with outgasing of the bonding layer. There has also been an important advance in the formation of low resistance Ge/Ag contacts.

During the review meeting it was explained that fabrication of a second batch of the full nanolaser devices will be completed in the coming months. Characterisation of these devices will determine if a successful outcome for the nanolaser can be reached, and if they can be implemented in a demonstrator, within the revised Navolchi term. If such a development is possible, this would be an impressive outcome from the project. It was recommended to make an updated version of deliverable D3.3 ("Fabrication of a plasmonic laser device") expected by Feb/March, which includes the new results.

Two types of plasmonic modulator have been realised, based on absorption and phase modulation. The absorption modulator shows 6dB extinction for a 5 micron device and a frequency response to 10 MHz. Very impressive results have been presented for the phase modulator, demonstrating 40 Gb/s modulation with 3dB extinction ratio for a 29 micron long device and an extinction ratio of 12-14 dB. This is undoubtedly one of the success stories of the project. The phase modulator will be used in an interconnect demonstrator before the end of the project.

Interesting results have also been obtained for a metallic grating to allow free space coupling between chips. This structure has been predicted to allow a theoretical coupling efficiency of 89% with removed parasitic reflections from wafer handle. Although not part of the original deliverables, the partners have offered to include results on the metal grating coupler in the planned update to deliverable D3.3 and added new milestone MS51.

WP4: Plasmonic Receiver

The development of the plasmonic receiver devices (amplifier and detector) lags behind that of the transmitter devices and at this point it is not clear if they can progress sufficiently to be included in the demonstrator systems. Despite this there has been interesting and valuable progress on the amplifier and detector devices, especially on the synthesis and gain characterisation of HgTe quantum dots, that is promising for their future utilisation.

The partners have demonstrated that the excitonic absorption of HgTe quantum dots can be tuned over a wide wavelength range by isolating quantum dots of different diameters. A wavelength of 1.55 microns is achieved with 5nm quantum dots. HgTe quantum dots in solution demonstrate optical gain 2.5 ns after the pump pulse. In close packed layers the gain lifetime is reduced to 100ps and as a result no amplification is found in dielectric waveguides. Future work will concentrate on fabricating new amplifier devices with improved nanocrystals, which have been available only in limited quantities so far.

PbS quantum dot Schottky photodetectors have been fabricated with a responsivity of 0.1 to 0.3 A/W. However, the devices have limited frequency response (to 10MHz) and require high bias voltages, so are not suitable for interconnects at this stage. Work with nanogap structures will proceed in future.

WP5: Optical and Electrical Interfaces for Plasmonic Interconnection Platform

WP5 focuses on the development of the photonic and electronic interfaces required to integrate all individual device together. Taper waveguide (Task 5.1) couplers have been produced with a loss of 0.4 dB/micron and an insertion loss of 0.8dB. Optical beam steerers (Task 5.2) for chip to chip free space coupling have been designed and are currently being fabricated. However, the simulations show that optical cross talk is significant and the project will therefore focus upon fibre coupling between chips. The other tasks in this WP have completed satisfactorily.

WP6: Integration, Characterisation, Testing

WP6 concerns characterisation of the plasmonic devices and their integration into interconnect demonstrators. It will naturally become one of the most important workpackages during the remaining term of the project. As discussed above, ETH Zurich has taken over ST's role in preparing the system demonstrators.

The demonstrator will use an off-chip laser source, a plasmonic phase modulator and conventional Ge p-i-n photodiodes. The project have decided to use fibre coupling between the transmitter and receiver chips, as this has lower interchannel coupling than free space coupling, can use commercial fibre arrays and allows the possibility of additional optical amplification. This seems a sensible approach.

It was not clear from the progress report and presentations if the partners will attempt an interconnect demonstrator implementing any of the other plasmonic devices, such as the nanolaser or the plasmonic photodetectors. During the review meeting the partners confirmed an intention to attempt a second demonstrator involving direct modulation of the nanolaser, if it is fabricated and demonstrates sufficient performance in time. A decision about the viability of this second demonstrator will need to be reached in Jan 2015 to ensure the drive electronics are in place by the end of the project.

The reviewers have recommended that this information be included in delayed milestone (MS39) in early 2015 to define the precise form of the interconnect demonstrators.

WP7: Dissemination
This is discussed in Section 5 below.

c. Milestones and deliverables

Indicate whether the planned milestones and deliverables have been achieved for the reporting period (please give more detailed comments first and then fill in the summary table below).

In general, the standard of the milestone and deliverable documents was good. There is a delay in the submission of deliverables 2.5 ("Techno-economical evaluation with respect to the cost efficiency and green aspects") and 2.6 ("Report on new applications and their opportunities") of WP2. It was not clear to the reviewers why they have been delayed. It was clarified during the meeting that D2.5 is delayed because the laser characteristics are unknown and it will be submitted M45 after the laser has been characterised. Deliverable 2.6 will also be submitted in month 45.

STATUS OF DELIVERABLES			
No.	**Title**	**Status** *(Approved/Rejected)*	**Remarks**
Deliverables approved in previous reviews			
D1.1	Project website	Approved	
D1.2	Project reference online manual	Approved	Condensed version of Annex II and Consortium Agreement
D1.3	Project quality online assurance manual	Approved	A useful document summarising procedures for D, MS, prototypes
D1.4	Intermediate progress report	Approved	First 9 months
D2.1	Definition of chip to chip interconnection system environment and specification (3)	Approved	Submitted D2.1 has different title to the DoW, but close to the expected content. It does not adequately discuss the potential impact of plasmonic technology.
D2.2	Definition of plasmonic devices (12)	Approved	Specifications of the various devices to be fabricated. Not clear how these relate to the system level goals.
D3.1	Report on optimised structure for metallic/plasmonic nanolaser and its coupling to Si WGs (12)	Approved	
D3.2	Report on modelling of the modulator structure (12)	Approved	
D4.1	Designs of plasmonic amplifiers (18)	Approved	
D4.2	Report on optical properties of	Approved	

	QDs layers and polymer nanocomposites (18)		
D5.1	DDCM specification document (6)	Approved	
D5.2	DDCM with electrical PHY design and verification data base (12)	Approved	
D7.1	First report on NAVOLCHI dissemination and promotion activities (18)	Approved	
D7.2	First report on NAVOLCHI exploitation activities (18)	Approved	
D7.3	Mirror Deliverable of D7.1, which will be available to the public on the website. (18)	Approved	
D7.4	Intermediate report on recent achievements. (18)	Approved	
Deliverables due in this review			
D1.5	Intermediate Progress Report	Approved	Covers month 27-36
D2.3	Investigation of chip to chip interconnection level specification employing new plasmonic devices	Approved	The main conclusion is that the nanolaser and phase modulator can only be implemented separately. Results in D2.3 may be updated after all the device characteristics are known.
D2.4	Interface and plasmonic interconnect models and reports	Approved	ok
D2.5	Techno-economical evaluation with respect to the cost efficiency and green aspects (30)		Delayed to month 45
D2.6	Report on new applications and their opportunities (36)		Delayed to month 45
D3.3	Fabrication of plasmonic laser device (33)	Draft reviewed	To be updated after nanolaser results available and to include the metal grating coupler results
D3.4	Report on fabrication of modulators (24)	Approved	ok
D4.3	Report on fabrication of modulators (24)	Approved	ok
D4.4	Report on SPP amplifiers by using QDs (30)	Approved	ok
D5.3	Compact optical filters and first generation beam shapers (21)	Approved	ok
D5.4	Generic DDCM compatible with plasmonic based PHY specification document (24)	Approved	ok
D5.5	Report on plasmonic waveguide couplers (24)	Approved	ok
D5.6	Generic DDCM compatible with plasmonic based PHY design and verification data	Approved	ok

	base (39)		
D6.1	Report on characterisation results of all plasmonic devices (27)	Approved	ok
D6.2	Report on characterisation results of all optical interface plasmonic passive components (27)	approved	ok
D6.3	Report on chip to chip interconnect characterisation	Rescheduled in amendment 1	New date: month 45

STATUS OF MILESTONES			
No.	**Title**	**Status** *(Approved/Rejected)*	**Remarks**
Milestones approved in previous reviews			
MS1	Definition of chip to chip interconnection system environment and specification (3)	Approved	This MS is identical to D2.1
MS2	Definition of plasmonic devices and material properties for chip to chip interconnection (6)	Achieved according to D2.2	Milestone report MS2 has been superseded by D2.2 which is a considerable improvement.
MS8	Decision on an optimised structure for metallic/plasmonic nano-laser and its coupling to Si waveguide (6)	Approved	Superseded by D3.1
MS9	Decision on a optimised structure for plasmonic modulator (6)	Approved	
MS10	Grown wafer structure for plasmonic lasers (12)	Approved	
MS16	Demonstration of decision on optimised structures for plasmonic amplifiers (12)	Approved	Not clear how plasmonic amplification at 600nm related to project goals.
MS17	Synthesis of nanopartictles with gain at 1550nm (12)	Approved	
MS25	Decision on optimised plasmonic waveguide couplers (6)	Approved	
MS26	Fabrication of plasmonic waveguide couplers with less than 3dB coupling loss (12)	Approved	
MS27	Design of first generation beam shapers and compact optical filters (12)	Approved	
MS28	DDCM with electrical PHY design and verification (12)	Approved	
MS37	Plasmonic active device characterisation results (12)	Approved	
MS44	Dissemination of activities in the project website and continuous update (1)	Approved	

MS45	Press release on start of project to the public demonstrated (2)	Approved	
MS18	Demonstration of conductive QD layers with photoconductive properties (15)	Approved	
MS19	Demonstration of metal-(lithographic) polymer and QD metal-(lithographic) polymer nanocompo-sites (15)	Approved	
MS20	Demonstration and decision on photodetector operation: nano-gap (MIM) vs. Schottky / heterostructure (18)	Approved. Partly achieved	There is no final decision on photodetector operation: nano-gap (MIM) vs. Schottky / heterostructure
MS3	Development of a system and device simulation platform (18)	Approved	
MS4	Definition derivation of the interconnection level specification (18)	Approved	Delayed but received for July meeting
MS11	Fabrication of plasmonic modulator on a SOI platform (15)	Approved	
MS12	Decision on an optimized structure for plasmonic modulator with a maximum loss of 20dB (18)	Approved	
MS13	Initial characterization of unbounded plasmonic lasers (18)	Cancelled	Decision to bound nanolaser to Si and then characterize.
MS21	Electrolumunescence from QD stack embedded within conductive oxides (> 1μW)	Approved	Missed in Periodic Report for WP4, but received for WP5
MS29	Data codecs for power consumption reduction (15)	Approved	
MS30	Decision on plasmonic waveguide couplers with less than 3 dB coupling loss (15)	Approved	
MS31	Fabrication of compact optical filters and first generation beam shapers (18)	Approved	
MS32	Data codecs for error detection and correction (18)	Approved	Missed in the description of Periodic Report for WP5, but received the copy.
Milestones due in this review			
MS5	Digital domain to plasmonic domain interface specification	Approved	ok
MS14	Initial testing and characterisation of plasmonic modulators	Approved	ok
MS22	Demonstration of plasmonic amplifiers with optical pumping demonstrating 10dB gain	Approved	10dB gain not yet demonstrated for an amplifier device. The document suggests the intrinsic gain of the nanocrystals in solution is

			sufficient.
MS6	Plasmonic interconnect VHDL modelling	Approved	ok
MS15	Initial testing of bonded plasmonic lasers	Approved	Bonded lasers yet to be realised due to delay in fabrication. Expected in revised D3.3
MS23	Operation of QD based photodetector with responsivity > 0.1A/W	Approved	The responsivity is about 0.08 A/W, close to the target value.
MS33	Design of second generation beamshapers (24)	Approved	ok
MS34	Generic DDCM compatible with plasmonic based PHY (24)	Approved	ok
MS38	Plasmonic passive components characterisation results with a 1dB coupling loss (24)	Approved	Coupling loss is below 1dB.
MS39	Concept for system integration developed (27)	Delayed	Rescheduled for month 40
MS7	Investigation of the cost and power consumption efficiency of the developed plasmonic devices (28)	Delayed	Rescheduled for month 45
MS24	Demonstration of SPP amplifiers with electrical injection exhibiting 10dB/cm gain (30)	Delayed	Rescheduled for month 45
MS46	Identification of possible contributions to the industrial partners for commercialization (15)	Approved	ok
MS47	Organisation of workshop on Si photonics interface chip to chip communications (34)	Delayed	Expected in December 2014
MS50	Final Plan of System Demonstrator	New milestone added	Expected for month 41
MS51	Report on Enhanced Metal Grating Couplers	New milestone added	Expected for month 41

d. Relevance of objectives

Indicate whether the objectives for the coming periods are (i) still relevant and (ii) still achievable within the time and resources available to the project. Assess also whether the approach and methodology continue to be relevant.

The overall objectives of the project of developing small footprint, low power, high bandwidth chip to chip interconnects are still very relevant and important. The consortium has decided to focus on particular device designs, such as the metallo-dielectric laser and SPP phase/absorption modulator. The decisions are carefully argued and the respective device targets seem achievable.

e. For Networks of Excellence (NoEs) only

Assess how the Joint Programme of Activities has been realised for the period and whether all the planned activities have been satisfactorily completed.

n/a

3. RESOURCES

a. Assessment of the use of resources

Comment on the use of resources, i.e. personnel resources and other major cost items. In particular, indicate whether the resources have been utilised (i) to achieve the progress and (ii) in a manner consistent with the principle of economy, efficiency and effectiveness[1]. Note that both aspects (i) and (ii) have to be covered in your answer. The assessment should cover the deployment of resources overall and by each participant. Are the resources used appropriate and necessary for the work performed and commensurate with the results achieved? Are the major cost items appropriate? In your assessment, consider the person months, equipment, subcontracting, consumables and travel.

As this is an Intermediate Project Review, no finance, manpower or Form C information was presented to the reviewers.

b. Deviations

If applicable, please comment on major deviations with respect to the planned resources.

(not applicable – see above)

[1] "The principle of economy, efficiency and effectiveness refers to the standard of "good housekeeping" in spending public money effectively. Economy can be understood as minimising the costs of resources used for an activity (input), having regard to the appropriate quality and can be linked to efficiency, which is the relationship between the outputs and the resources used to produce them. Effectiveness is concerned with measuring the extent to which the objectives have been achieved and the relationship between the intended impact and the actual impact of an activity. Cost effectiveness means the relationship between project costs and outcomes, expressed as costs per unit of outcome achieved." Guide to Financial Issues, Version 02/04/2009, p.33.

4. MANAGEMENT, COLLABORATION AND BENEFICIARIES' ROLES

a. Technical, administrative and financial management of the project

Assess the quality and effectiveness of the project management, including the management of individual work packages, the handling of any problems and the implementation of previous review recommendations. Comment also on the quality and completeness of information and documentation.

An appropriate management structure for the project has been established. Guidelines have been put in place for the implementation of the project plan, as well as the preparation of the project milestones and deliverables. M Kohl (KIT) has taken over the role of Technical Project Manager and Coordinator.

b. Collaboration and communication

Comment on the quality and effectiveness of the collaboration and communication between the beneficiaries.

There has been good communication between the partners with 6 face to face meetings and 30 telephone meetings. There is appropriate collaboration between the partners in the various workpackages.

c. Beneficiaries' roles

Give an assessment of the role and contribution of each individual beneficiary and indicate if there is any evidence of underperformance, lack of commitment or change of interest.

The individual beneficiaries are well suited and committed to their tasks in the project.

5. USE AND DISSEMINATION OF FOREGROUND

a. Impact

Is there evidence that the project has so far had, and is it likely to have, significant scientific, technical, commercial, social or environmental impact (where applicable)?

Plasmonic phase modulators developed in the project have shown impressive characteristics and may find applications for optical interconnects or low cost Silicon based optical modulators used in telecommunications. The full potential of low threshold nanolasers and low cost quantum dot based optical amplifiers are not yet fully realized in the project, but could also have attractive applications.

b. Use of results

Comment on whether the plan for the use of foreground, including any updates, is still appropriate. Comment also on the plan for the exploitation and use of foreground for the consortium as a whole, or for individual beneficiaries or groups of beneficiaries, and its progress to date.

The plan for use of foreground is unaltered and still appropriate. Two patents have been filed by the consortium and 8 PhD and MSc theses have been defended.

c. Dissemination

Assess whether the dissemination of project results and information (via the project website, publications, conferences, etc.) has been adequate and appropriate.

The consortium have set up a project website containing general information. They also made a press release at the start of the project and have printed a project leaflet for distribution at conferences and trade fairs. There have been 11 journal papers (including a paper in Nature Photonics on the plasmonic modulator) and 22 conference papers within the last nine months.

d. Involvement of potential users and stakeholders

Indicate whether potential users and other stakeholders (outside the consortium) are suitably involved (if applicable).

The development is still in an early phase and so contact to potential users has been limited so far. Identification of possible contributions to the industrial partners for commercialization (milestone MS 46) was delayed due to the reorganization process at ST.

e. Links with other projects and programmes

Comment on the consortium's interaction with other related Framework Programme projects and other national/international R&D programmes and standardisation bodies (if relevant).

A workshop was held by the NAVOLCHI consortium at the ICTON 2012 conference in Warwick and at the ICTON 2013 conference in Cartagena. This also involved another EU project in this area PLATON.

6. OTHER ISSUES

If applicable, comment on whether other relevant issues (e.g. ethical issues, policy/regulatory issues, safety issues) have been handled appropriately.

None to report

Name(s) of expert(s): Date: Signature(s):