



**START DATE:** 1st January, 2015  
**DURATION:** 36 Months  
**EU FUNDING:** 3,333 MEuro (3.333.723,00 EUR)  
**REFERENCE:** 644678



This project is funded by the Horizon 2020 Framework Programme of the European Union

## Welcome to the third edition of the TWEETHER newsletter!

TWEETHER is a European research initiative, funded under H2020, that brings together world-leading European industries and academic institutions across Europe to set a milestone in the millimeter wave technology with the realization of the first W-band (92-95GHz) wireless system for distribution of high-speed Internet everywhere.

TWEETHER just completed the first half of the project and through this issue of the newsletter, we bring you updates about the results achieved in the enabling components of the TWEETHER system.

Key technologies under development include novel wide band W-band Traveling Wave Tube (TWT) amplifiers capable to provide the level output power to distribute millimeter wave frequency signals in a wide area, W-band chipset based on Monolithic Microwave Integrated Circuit (MMIC), high performance synthesizer and W-band antennas with different apertures and gains for the transmission hub and terminals.

In particular, the concepts underpinning the project and the preliminary achievements of the TWT are further described in this newsletter.

More information is available on the project website: [www.tweether.eu](http://www.tweether.eu)

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## TWEETHER system

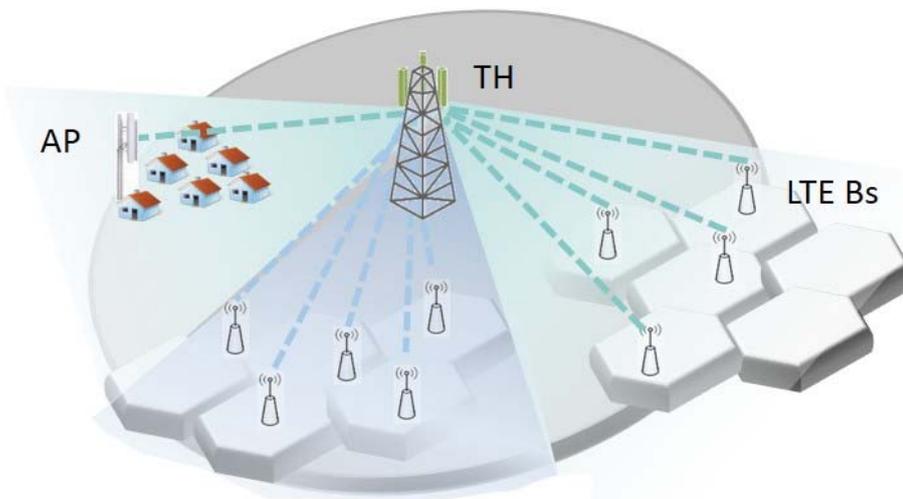
The TWEETHER breakthrough is to develop the first W-band (92-95 GHz) wireless system for distribution of high-speed Internet everywhere. To this end, TWEETHER proposes to exploit the benefits of millimeter wave technology at W-band and point to multipoint (PmP) architectures to efficiently provide a capacity and coverage of up to 10 Gbps/km<sup>2</sup> suitable for future high-speed wireless transmission applications such as backhaul for 4G and future 5G small cells and broadband residential fixed access.

To achieve this goal, the three main aspects underpinning the TWEETHER project are:

**Frequency:** TWEETHER exploits the W-band, centered at 94 GHz, to enable high capacity distribution. This band offers 3 GHz bandwidth and is light licensing for PmP.

**Architecture:** The TWEETHER system is considered part of a three tier architecture: fiber, capacity distribution, users. In particular, the TWEETHER system addresses the connecting tier between the fiber infrastructure and the user tier, distributing huge aggregate capacity to several terminals with massive savings in equipment, site rental and licensing costs due to the use of a PmP architecture.

**Technology:** The success of the TWEETHER project is being fostered by the realization of novel traveling wave tubes (TWTs), the MMIC chipset and radio subassembly in W-band with performances widely beyond the state of the art.



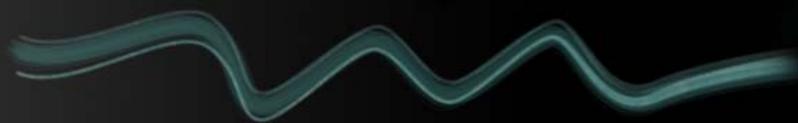
*The service area covered by a Transmission Hub (TH) is divided in sectors. Each sector supports a sub-net that distributes the capacity to a number of small cells (LTE base stations) or residential access points (AP).*

The first implication of using PmP transmissions for service provision in a wide area is that, differently from narrow beam antennas used in point to point (PtP) links, a low directive antenna is required. On the other hand, the atmospheric attenuation in rain condition is one of the main obstacles for propagation at millimeter wave (mm-wave) frequencies and is a key factor to be considered for the design of a W-band system. Therefore, due to the high attenuation in the mm-wave region and the requirement of low directive antennas for PmP configuration, the output power at the TH must be substantially higher.

A coverage model has been implemented and used to determine the output power specifications of the transmission hub and the terminals for providing 10Gbps/km<sup>2</sup> in 1-km radius area:

- 1 W (saturated) for the terminal,
- 40 W or 46 dBm (saturated) for the TH.

It is notable that the main technological challenge in W-band to enable the proposed wireless systems is to satisfy the need of power at the terminal and at the transmission hub



## W-band Traveling Wave Tube

The computation of the power requirement to enable PmP transmissions reveals the great challenge of millimeter wave wireless communications. Indeed, no amplifier with a saturated power level in the range of 40W and sufficient bandwidth is available today for wireless communication systems at millimeter waves.

The TWEETHER project is addressing this challenge by introducing a novel technological solution based on a Traveling Wave Tube amplifier (TWT) integrated at the transmission hub to guarantee the output power required for the capacity and range targets.

The TWT specifications, derived by an accurate link budget model, are detailed below:

### TWT Specifications

**Frequency: 92 - 95 GHz**

**TWT Gain: 30 dB minimum (40 dB expected)**

**Saturated output power: about 40 W**

**Operating environment: outdoor -10°C +55°C**

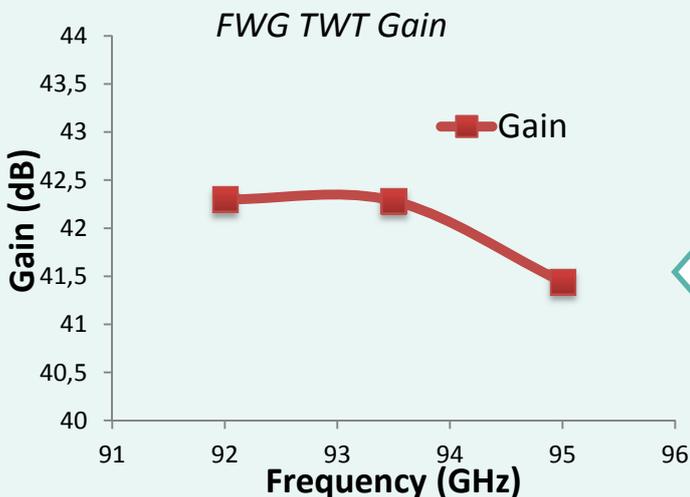
**Dimensions: less than 5 dm<sup>3</sup> (15 dm<sup>3</sup> including the power supply)**

**Weight: < 3kg**

The challenge is demanding due to the convergence of two conflicting requirements: high technology approach for performance and low cost for massive productions.

The first prototype of the Traveling Wave Tube has been designed. In particular, a folded waveguide (FWG) has been chosen for the well-known properties of wide band and relatively easy fabrication.

Simulation results show that the FWG TWT gain obtained with this design is over 40 dB in the whole frequency range, thus fulfilling the specifications.



First samples of the fabricated FWG are shown in the figure beside. The small section of the waveguide requires high precision CNC milling to be realized with tolerance in the micron range. The beam optics is also in advanced fabrication phase.

## Dissemination

### Conference papers and workshop presentations:

- » Claudio Paoloni (Lancaster University) participated at the International Vacuum Electronics Conference (IVEC2016, Monterey US) presenting how the TWEETHER project could impact on the TWT market bridging the vacuum electronics from a niche market to a large volume market.
- » TWEETHER was invited to the Workshop on Key enabling technologies on antenna and channel models for an effective mmWave 5G deployment, which was organized at the European Conference on Antennas and Propagation (EuCAP 2016, Switzerland). Ruth Vilar (Universitat Politècnica de Valencia) presented the TWEETHER project.
- » Ruth Vilar and Antonio Ramirez (Fibernova) participate to the organization, led by Valerio Frascolla (mmMAGIC), of the joint special session of the mmMAGIC, TWEETHER, MiWaves and MiWEBA projects titled “Millimeter-waves as a key enabling technology for 5G: Status of the pre-development activities and way forward” at the European Conference on Networks and Communications (EuCNC 2016, Athens, Greece). Claudio Paoloni gave the talk “W-band point to multipoint system for small cells backhaul”.
- » TWEETHER participated at the 25th European Conference on Networks and Communications (EuCNC 2016). Claudio Paoloni presented the new concept of front-end radio based on a novel W-band vacuum electron device and a high performance transceiver as proposed in the project.
- » TWEETHER project was invited to participate in the annual RF MST Cluster Meeting (co-organized by the European Commission), which took place on 4th July 2016 in Bucharest, Romania. Viktor Krozer (Goethe University of Frankfurt) presented the TWEETHER project.



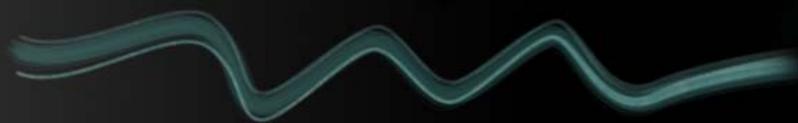
### Public deliverables:

- » D7.5 – Data management Plan (version 2)
- » D7.6 – Dissemination & Communication Report



## TWEETHER in the press

- » TWEETHER is mentioned in the report “Living without electricity - One city’s experience of coping with loss of power” published by the UK’s national academy for engineering (RAEng) as a novel rapidly deployable millimeter wave communication system capable of providing broadband connectivity at an affordable cost.



## Save the date

### TWEETHER at the International Conference on Infrared, Millimeter and Terahertz Waves – IRMMW-THz 2016 (25-30 September in Copenhagen, Denmark)

The International Conference on IRMMW-THz is the oldest and largest continuous forum specifically devoted to the field of ultra high frequency electronics and applications.



Claudio Paoloni will present the latest results on the fabrication of the W-band TWT for the TWEETHER Transmission Hub.

More information: <http://www.irmmw-thz2016.org/>



### TWEETHER at the European Microwave Week – EuMW 2016 (3-7 October in London, UK)

Bringing industry and academia together, European Microwave Week 2016 is a five day event, including three cutting edge conferences and one exciting trade and technology exhibition featuring leading players from across the globe.

Claudio Paoloni, TWEETHER, and Valerio Frascolla, mmMAGIC will chair a workshop on “**Millimetre-Wave Electronics for High Capacity Wireless Networks**”, which will offer the vision on the state of the art in the field of millimeter wave wireless networks through the latest update from ten renowned experts from operators, electronic manufacturers and academia.

Roberto Dionisio (European Space Agency) and Claudio Paoloni have organized a Short Course “The Basics of Travelling Wave Tube Amplifiers”. Claudio Paoloni will give a tutorial on “Slow wave structures for micro- and millimeter- waves”

Viktor Krozer will present TWEETHER in the workshop “Compact and High Performance Millimetre-Wave and THz Sources & Systems” organized by IBROW project.

**Monday 3<sup>rd</sup> October, 2016** Joint TWEETHER - mmMAGIC workshop on “Millimetre-Wave Electronics for High Capacity Wireless Networks”



**Monday 3<sup>rd</sup> October, 2016** Short Course “The Basics of Travelling Wave Tube Amplifiers”

**Friday 7<sup>th</sup> October, 2016** Workshop “Compact and High Performance Millimetre-Wave and THz Sources & Systems”.

Information and registration : [http://www.eumweek.com/conferences/workshop\\_schedule.html](http://www.eumweek.com/conferences/workshop_schedule.html)

## Follow TWEETHER

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 [linkedin.com/grps/TWEETHER-PROJECT-6954276](https://www.linkedin.com/grps/TWEETHER-PROJECT-6954276)

 [https://youtu.be/hoxOtDjQ\\_aE](https://youtu.be/hoxOtDjQ_aE) Watch the TWEETHER video!

