Fixed Wireless Access using an OFM RoF system

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Outline

- MUSE & FWA feeder objectives
- FWA & wireless standards
- OFM principle & FWA design
- Measurements & Results
- Conclusions
Low cost, full service access and edge network for ubiquitous delivery of broadband services to all European users.
Objectives FWA

1. Provide options for centralization of FWA head-end processing functions (simplified antenna units).
2. Establish feasibility of techniques for carrying microwave signals.
3. Protocol considerations
4. High level component & Network designs
FWA Deployment issues

- FWA is applied when fiber is no option
- Capacity requirement (100 Mbps) implies operation in 10 - 66 GHz region \(\Rightarrow\) LOS requirement \(\Rightarrow\) truck roll installation
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What is FWA?

- **wireless access** = end-user radio connection(s) to core networks (ITU definition), examples are: FWA, MWA and NWA
- FWA provides wireless communications between a fixed point and multiple terminals
- FWA networks are an alternative to ADSL and cable modem
Overview of wireless standards
IEEE 802.16 Key features

- Up to 134Mbps in 28 MHz channel (10 – 66 GHz air interface)
- Supports multiple frequency allocation from 2 – 66 GHz
- Supports multiple services simultaneously with full QoS
- Bandwidth on demand
- TDD and FDD, TDMA
- Point-to-Multipoint topology with Mesh extension
- Extensions to mobility (IEEE 802.16e)
- Max range 50 km (LOS) depending on tower height, antenna gain, and transmit power
RoF = analog optical link over which (modulated) electrical signals are transmitted (HE to RAU):

- simplified Remote Antenna Units
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Transporting microwave signals over a fibre link

- Sweeping laser wavelength across multiple passbands of optical periodic filter
- Sweep frequency $<<$ $\mu$-wave frequency
- Shared high-Q sweep freq. generator
Advantages of OFM

- Low-frequency components at the headend
- Greater RF power efficiency
- Low phase noise (pure carriers)
- More tolerant to chromatic dispersion
- Operation on multimode fibres
- Multi-standard support (frequency, modulation)
Bi-directional OFM system

Headend station

- $f_{sw}$
- MZI Mod.
- periodic BPF
- $\tau$
- WDM
- data down $f_{scm}$
- DAC
- AGC
- ADC
- BPF
- PD
- DSP

Radio Access Point

- Fiber link
- $\lambda_0$, $\lambda_1$
- WDM
- PD
- BPF$_1$
- MPA
- LNA
- circulator
- $f_{mm}$, $f_{scm}$
- LD
- BPF$_2$
- mixer
- BPF$_1$

- (De)modulation
- Filtering
- Synchronisation

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FWA lab trial measurement

• Main target:
  – proof of concept
  – Support of IEEE 802.16

• How:
  – Transmission of IEEE802.16 signals (QAM16, 100 Mbit/s)
  – EVM and power measurements
Measurement setup (Full-Duplex System)

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17.2 GHz carrier OFM generated from a 2.8 GHz signal

- $f_{sw} = 2.87$ GHz
- $f_{sc} = 600$ MHz
- Datarate = 100 Mbps
- $f_{mm} = 17.2$ GHz
Eye diagram for QAM16 modulation, with a symbol rate of 25 Msymb/s

- 100 Mbps

$f_{sc} = 600$ MHz

$f_{mm} = 17.2$ GHz

$f_{IF} = 600$ MHz
Modulation constellation

- EVM (upstream) = 5.5 %
- 100 Mbps

\[ f_{sc} = 600 \text{ MHz} \]
\[ f_{mm} = 17.2 \text{ GHz} \]
\[ f_{IF} = 600 \text{ MHz} \]
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Conclusions

- Overview of the FWA concept and related standards have been addressed
- A full duplex RoF system has been developed and tested for FWA
- Cost-effective system, easy to maintain and upgrade
- Supports a range of frequencies which are determined by drive parameters of the OFM process
- The observed EVM value is well in accordance with the specified EVM of 6% by the IEEE 802.16 standard