TV White Spaces – Focus On Channel Aggregation

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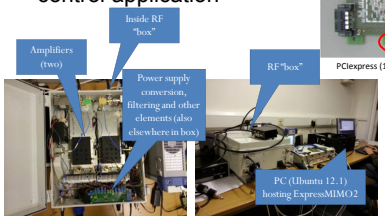
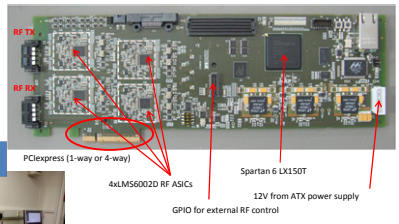
Background

- We are performing a wide-ranging series of trials of TV White Space (TVWS) technologies within the Ofcom TVWS Pilot. Some purposes
  - To test systems that may be implemented in TVWS
  - To assess effectiveness of ETSI 301 598 "conformance standard" for white space devices, and develop improvements to the TVWS framework
  - To perform research using TVWS implementations, e.g.,
    - Secondary coexistence (e.g., LTE with 802.11af in TVWS), and methodologies to improve secondary coexistence
    - To undertake studies and surveys on the performances that are achieved, e.g., coexistence with primary (!), secondary user performance through objective user opinion polling
  - **And particularly to study performance and solutions for aggregation of channels/links (e.g., TVWS with licensed and other unlicensed links such as ISM, and aggregation of channels solely within TVWS)**

Our Aggregation-Capable White Space Devices

- Eurecom/King's College ExpressMIMO2 software radios with white space control application

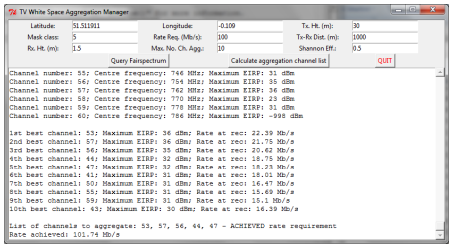




- InterDigital Devices
  - WiFi in TVWS aggregating up to 4 channels, contiguous or non-contiguous
- NICT Devices
  - LTE in TVWS, aggregating up to 3 contiguous channels (20 MHz carrier)

Activities (Subset of Aggregation Work)

- Implemented the TVWS framework from the device side, with a viewpoint to assessment of TV channel aggregation-related applications and use in some of our white space radios
- Testing potential for aggregation of TVWS channels (e.g., rates that are achieved)—includes extensive experimentation aspect
- Defining methodologies for aggregation, including heuristics
- Considering database-side solutions to assist white space device coexistence, particularly with a view to aggregation management

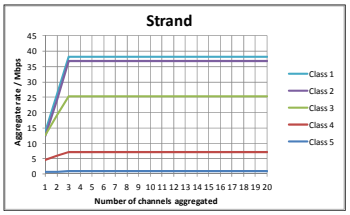


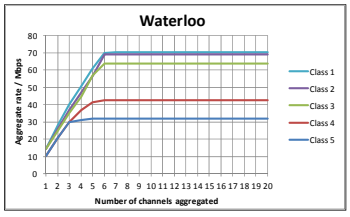
Why Aggregate?

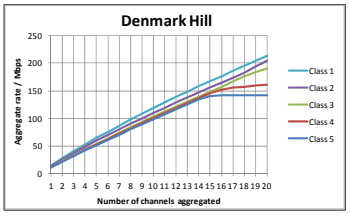
- Each TV channel is 8MHz bandwidth (in ITU Region 1); may wish to use higher bandwidth (achieve higher capacity) than that
- TVWS access is license-exempt – a white space device could experience significant interference from other white space devices
  - Higher powers are allowed in TVWSs (4W EIRP) and propagation is much better than in most other common license-exempt bands
- For some locations and classes of devices, allowed powers low
- In some scenarios (e.g., long-distance above-rooftop links) interference from TV transmitters that are not meant to be covering the area can be an issue (even where maximum power of 4W EIRP is allowed for the white space devices)
- Can mitigate such issues through aggregating more spectrum; still achieve required capacity, greater diversity against interference, etc.

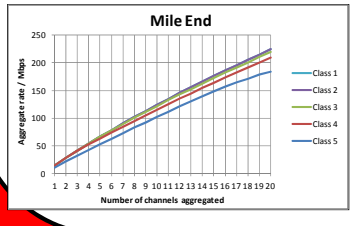
Some Example Results

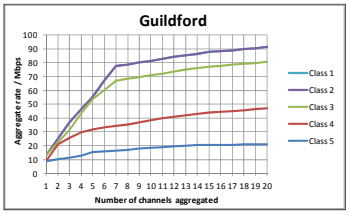
- Aggregate rate against number of channels aggregated for some of the locations used in our trials. Class 1 and class 2 results sometimes identical. Channel selection rule: max power, and if power is equal then lowest frequency. Same config as for results on right



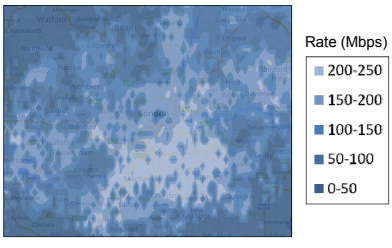




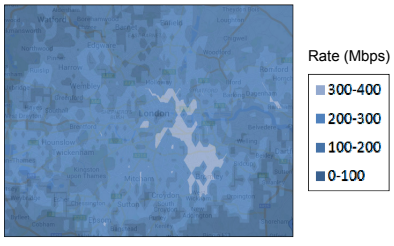




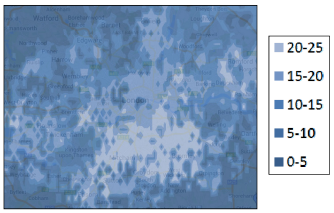
- Optimally aggregating all available TVWS channels for different transmitter locations in London (~M25 area). Average rate achieved for 2km link, Tx height 30m, Rx height 1.5m, Shannon efficiency 0.5, Hata urban, class 5



- Class 1



- Number of TV white space channels available with allowed power of >=30 dBm EIRP, London (~M25 area), class 5



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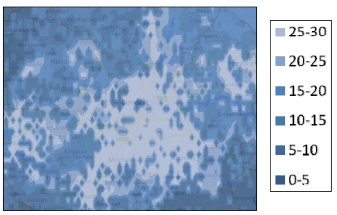

Achieved Rate (Mbps)

	Class 1	Class 2	Class 3	Class 4	Class 5
Average	167.0	165.1	155.4	130.9	104.7
STD	84.2	84.4	82.5	77.4	66.8
CoV	0.50	0.51	0.53	0.59	0.64

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SEVENTH FRAMEWORK PROGRAMME

SOLDER ACROPOLIS
European NoE on Cognitive Communications