COST-TERRA
COST Action IC0905 TERRA

Dedicated "cognitive radio" band for future innovative wireless services

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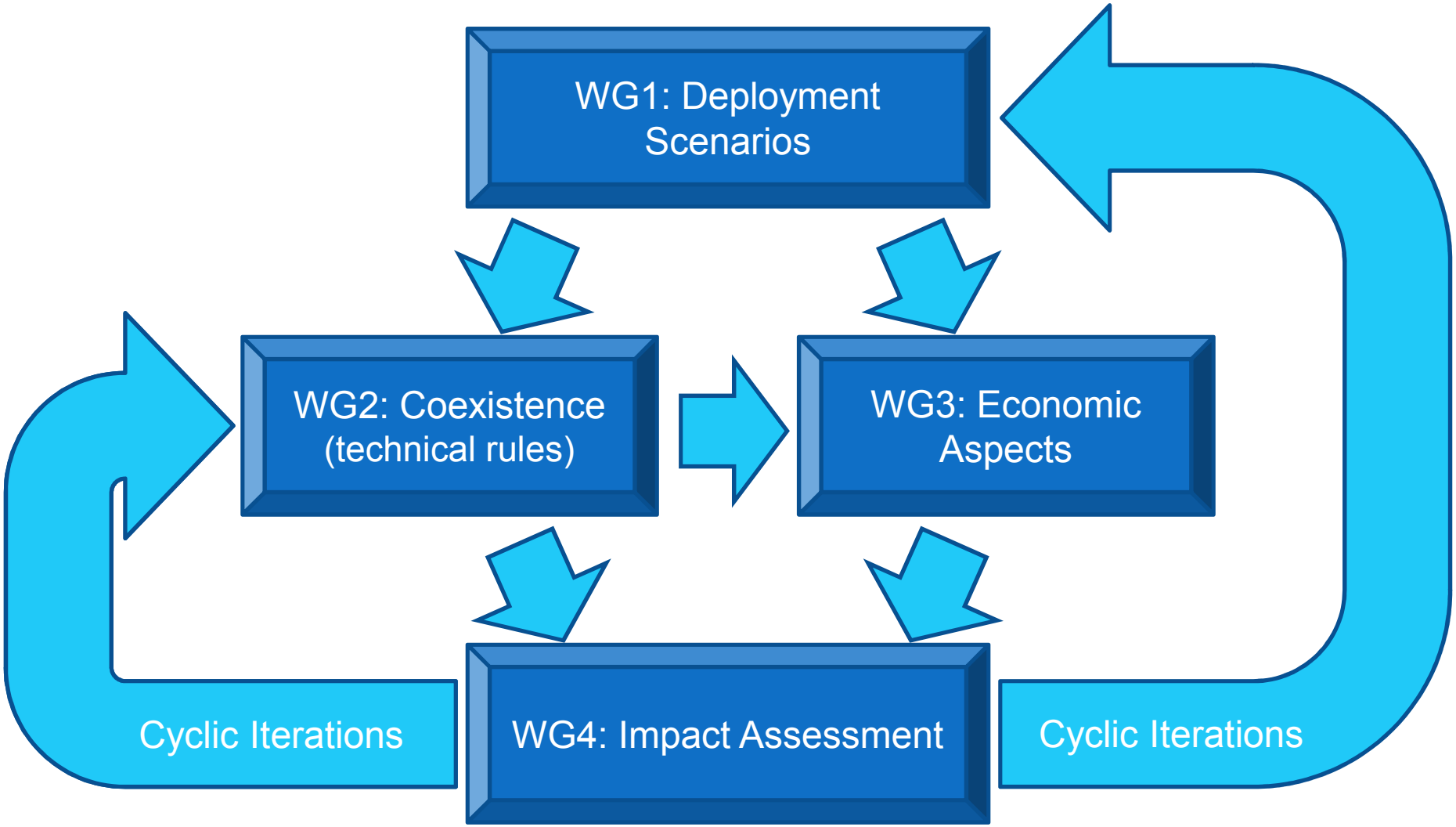
COST-TERRA

Introducing COST-TERRA

About COST-TERRA

- COST = European **CO**operation in **S**cience and **T**echnology
  - A European inter-governmental framework to promote international networking for R&D and standardisation, managed by the European Science Foundation
- COST action IC0905 "TERRA": "***T**echno-**E**conomic **R**egulatory framework for **R**adio spectrum **A**ccess for Cognitive Radio/Software Defined Radio*"
- Is an independent think-tank with broadly open participation from academia, industry and regulators
- General aim is to bring together technical and economic experts to spearhead a regulatory breakthrough for European development of CR/SDR

About COST-TERRA



“Dedicated Cognitive Radio Band”

The Past…

- License-exempt bands have proven to be a hot-bed of innovation in wireless field, as well as an entry point for "free" wireless communications:
  - Created plethora of novel applications and wireless uses.
  - Led to the development of popular standards such as WiFi, Bluetooth and ZigBee.
  - "Spill-over" of related innovation to other bands, such as WiFi/Hiperlan into 5 GHz, WiMAX, etc.
- However, the rich eco-system in 2.4 GHz band is built on one caveat – limited (low) transmit power, which hampers the scope/range of wireless services and does not effectively handle interference in busy areas.

The Past…

- Licensed bands have allowed reliable services:
  - Near-ubiquitous voice connectivity in public land mobile, and early data services (2G/3G/3.5G/…).
  - High-quality broadcast services , able to cope with even the cheapest or most poorly configured receiver hardware (or indeed analogue operation).
  - Guaranteed clean spectrum for critical services (e.g., military, air traffic control, emergency services, etc.).
- However, the efficiency of such bands has been questioned, as they are sparsely used at many times/locations, at a time when other users/services urgently require more spectrum.

The Present: Stalled Innovation

- A key impetus of wireless innovation and research interest has been Opportunistic/Dynamic Spectrum Access (OSA/DSA), enabled by Cognitive Radio.
- However the use of OSA/DSA often puts too heavy a burden on emerging wireless technologies and prospective market entrants, or is controversial for other reasons:
  - Extremely onerous technical requirements to protect incumbents from interference, if techniques such as “sensing” are used.
  - Significantly reduced opportunities for access, if a “database” is used.
  - Resistance of incumbents due to “fairness factor” (why should someone should use for free what I paid billions for?), as well as fears of competition, disruption of their existing business models, anxiety of spectrum being “encroached”.
  - Severe and yet to be defined certification requirements.

The Future…?

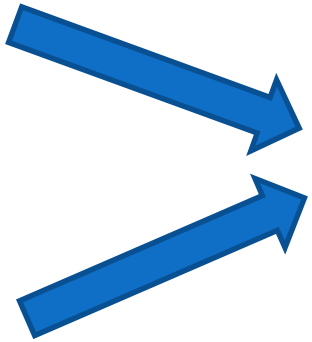
- A new assigned frequency band by the regulator, specifically for the purpose of dual-priority services, enabled by "cognitive radio" technologies.
- No need to cope with legacy systems. "Higher-priority" users must accept stricter technical limits to participate.
  - No need to account for poor out-of-band interference rejection, low receiver sensitivity or other insufficiencies of legacy systems as occur in TV whitespace, for example.
- Higher-priority participant has to obtain a licence to access the band. A coordination mechanism among higher priority assignments to be decided by the regulator.
- Lower-priority participants have to use "cognitive" mechanisms to access the band (detail of "cognitive" mechanism, however, is TBD).

Improved Efficiency/Innovation

- Implies vastly improved performance, e.g., in terms of spectrum efficiency, with a very small effect on the higher priority system as compared with equivalent "primary" system in TV white space, for example.
- Gives higher priority system better quality (guaranteed) spectrum access, while still allowing free access when/where the spectrum is not used for the lower priority system. Strikes good balance between those that want to pay for quality, and those that want access freely.
- Highly scalable to future deployment in additional spectrum bands, as well as progressive deployment of higher priority transmitters, using a licensing regime similar to "lite-licensing".
- Supports CR deployment, which has thus far been lacking.

License Fee Paying Example

Licence fee: E.g., could be decided based on estimated summation (integration) of implied radio-power over area (just one possibility), scaled by how "busy" the band is in the area

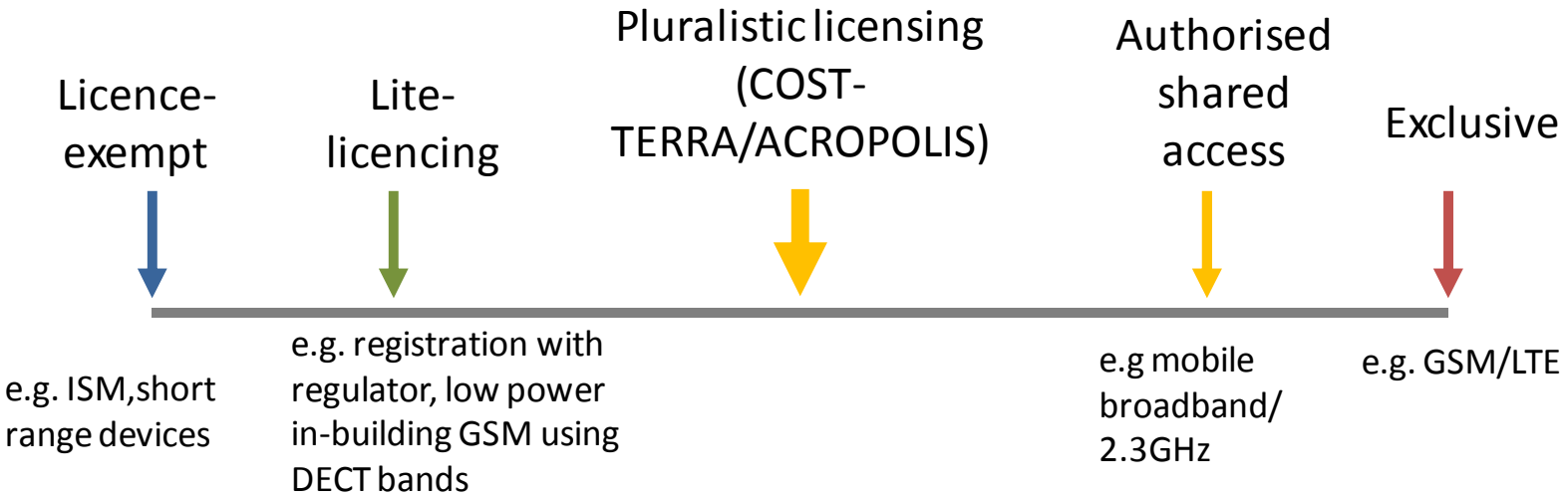


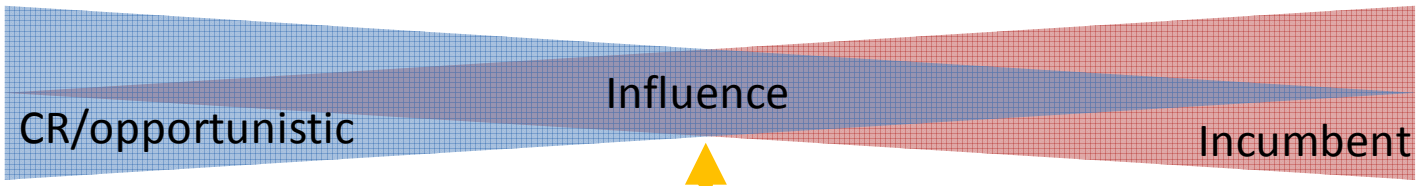
"Dual-priority band"

Reduced/zero licence fee. Must meet CR access requirements

Players have equal regulatory status, but license-fee paying users having priority in spectrum access mechanism

Pluralistic Licensing Concept





Equilibrium

CR/opportunistic and higher priority users have equal rights
Dual entry approach – value for both incumbents & new tech scaling up

Access Sharing Example

- **Heavily simplified** example of one way that such a concept *might* be chosen to work

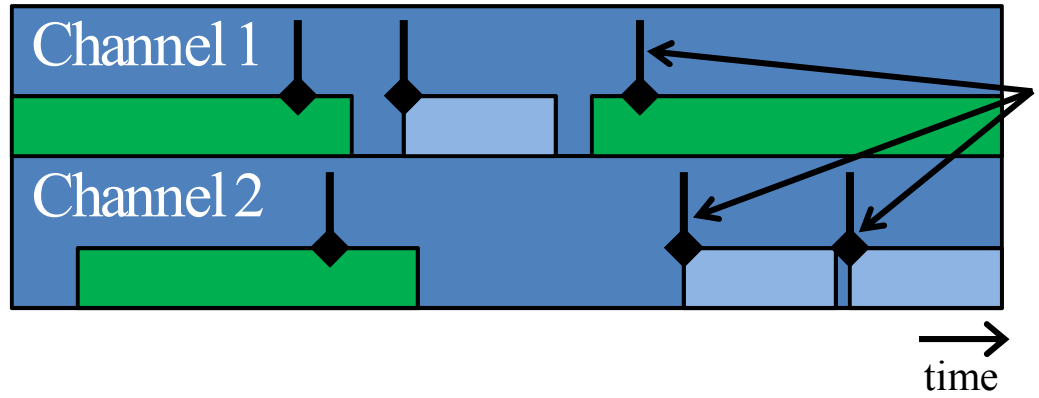
= Priority Access

Fee paid: No need to use cognitive access (no sensing or possible geolocation checks—can transmit whenever wished, without checks).

= "Cognitive" Access Transmissions

Reduced/zero fee paid: Must implement CR access requirements (e.g., collaborative sensing durations—represented by , possible geolocation database checks, etc.).

Dedicated Cognitive Radio Band: Players have equal status, i.e., no primary or secondary



Cognitive access collaborative sensing durations before transmissions

Spectrum for Such a Concept…?

- Even a comparatively narrow band of few tens of MHz could be sufficient to bring this new concept to reality
  - Usage of such a concept could be cautiously increased as more spectrum becomes available
- Some possible opportunities for bands for this new type of cooperative shared use band:
  - Slots freed by transition to more spectrum efficient digital Broadcasting (Second Digital Dividend)
  - Still largely unused TDD portions in land mobile frequency plans at 2 GHz (ref. ongoing RSPG reviews)
  - Little-used 1452-1492 MHz L-band (been investigated, and CEPT FM50 probably already too far into process)

Acknowledgments, References

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- Special thanks to the contributors to this presentation and concept: Arturas Medeisis, Oliver Holland, Keith Nolan, John Sydor, Luca de Nardis (list not exhaustive)

- For more information on COST Action IC0905 TERRA, please visit: www.cost-terra.org
- For more information on ICT-ACROPOLIS, please visit: www.ict-acropolis.eu

Thank You!

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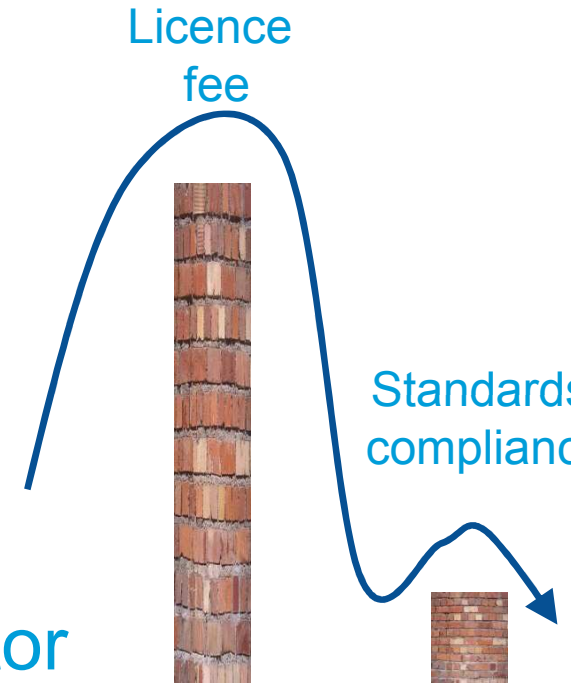
Back-up Slides

Market paywalls - cellco



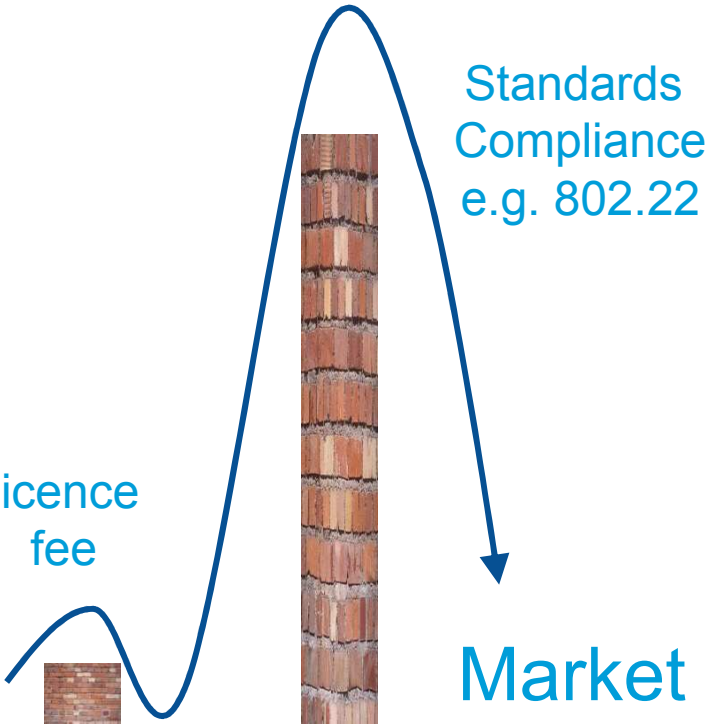
- New entrant
- Diversifying operator

e.g. LTE/Digital Dividend
€20m+ for 5MHz pairs (Ireland)

*Excluding site and infrastructure costs & OPEX

Market paywalls - TVWS*

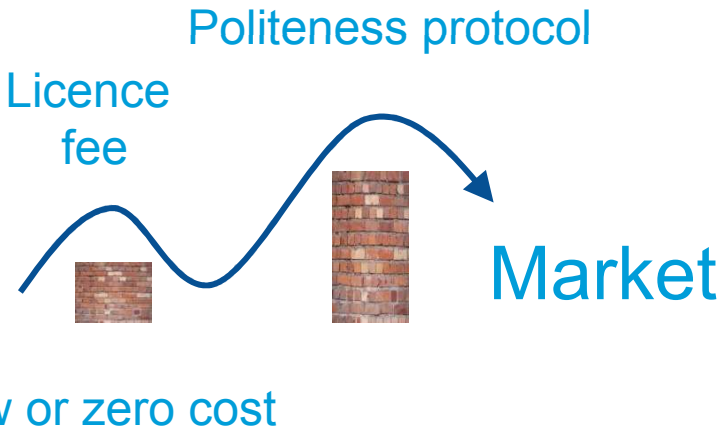
- New entrant
- Diversifying operator



*Excluding site and infrastructure costs & OPEX

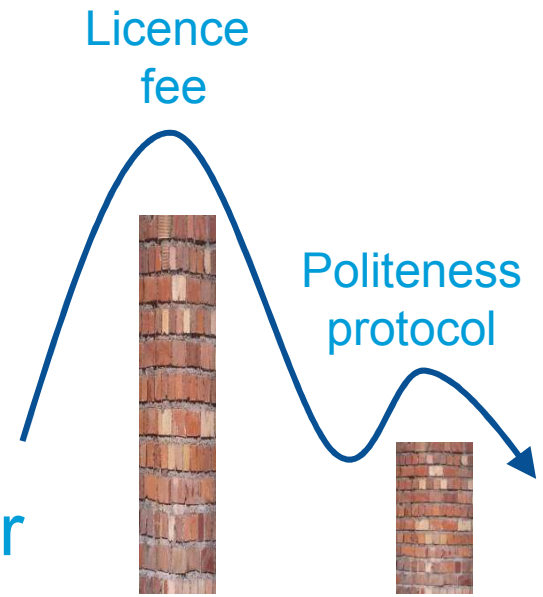
Market paywalls – new band (I)

- New CR entrant



*Excluding site and infrastructure costs & OPEX

Market paywalls – new band (II)



- Diversifying operator

Market

Reduced due to equal status rule

*Excluding site and infrastructure costs & OPEX

Requirements Alt. Example

- Initial idea for a set of "essential Cognitive Radio requirements" to qualify for access to the dedicated co-operative band:
  - Out-of-band emission requirements
  - Devices required to communicate their emission conditions
  - Devices required to collaborate on sharing of common spectrum
- Note:
  - For compliant devices - no principal limits on emitted power (except any applicable ITU RR limits)
  - Non-compliant devices may be still allowed into the band, subject to some low transmit power level

Strategies

- Lower barriers to entry for new entrants
  - Commercially viable spectrum
  - Light-touch regulation
  - Sliding cost scales / tie licence costs to success
- Carrier aggregation – existing operators
  - Dedicated CR band is open for as-needed aggregation (idea from Linda Doyle)
  - Non-CR tech can use but for higher costs

Some links

- Recent news showcasing the problem of interference in ISM band:
  - http://www.securityweek.com/smart-meters-interfering-home-electronics
- Yet another clash over frequency access:
  - http://www.techworld.com.au/article/408425/spectrum_clash_builds_around_bionic_implants
- CEPT work on trying to decide what to do with idle band 1452-1492 MHz:
  - http://www.cept.org/ecc/groups/ecc/wg-fm/fm-50
- European RSPG consultation on what to do with unused TDD blocks in 2 GHz land mobile band (deadline 18 January 2012):
  - http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/activities/index_en.htm#ongoing_consultations