



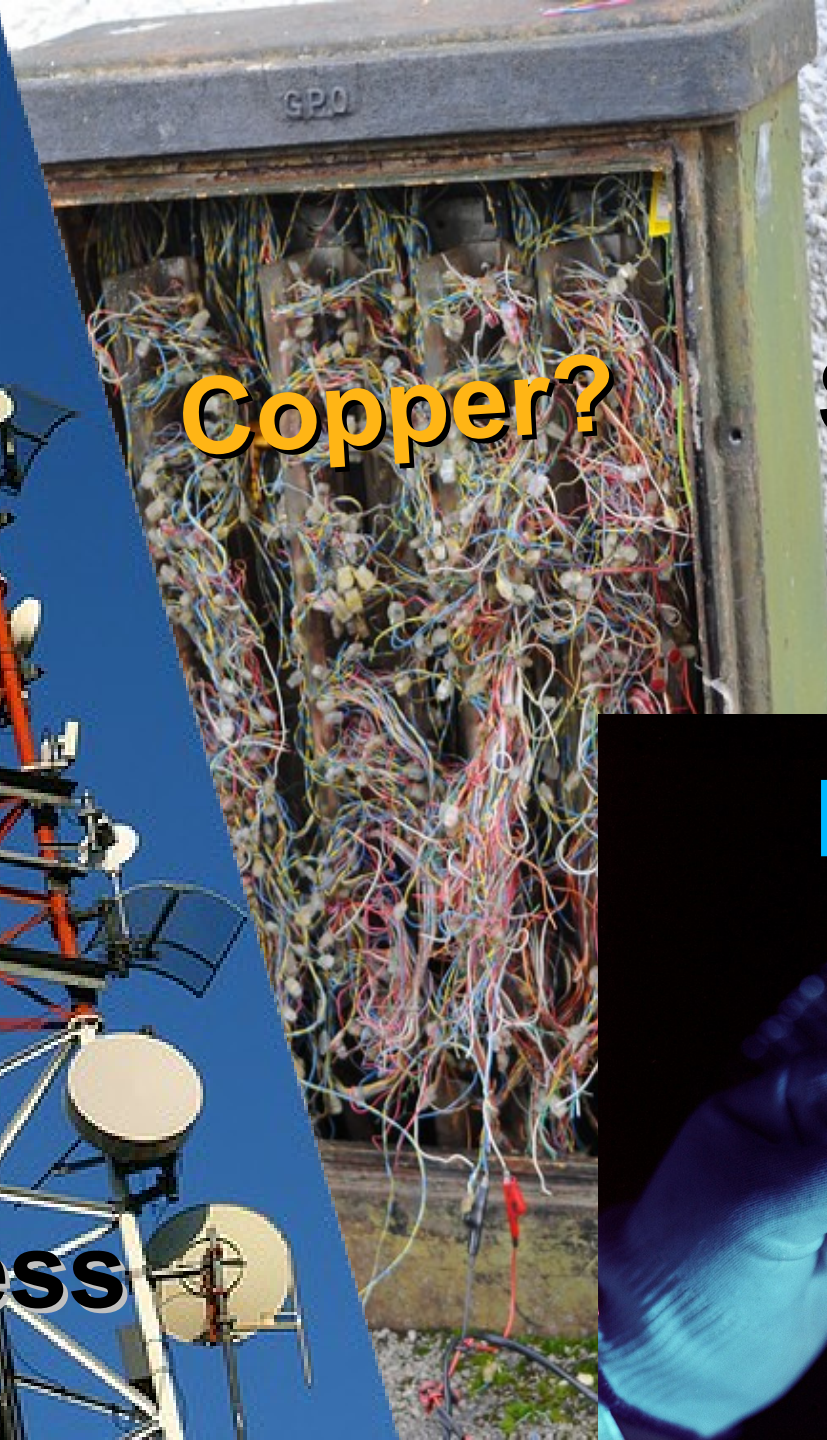
A Wireless Spectrum Primer



Steve Song
@stevesong

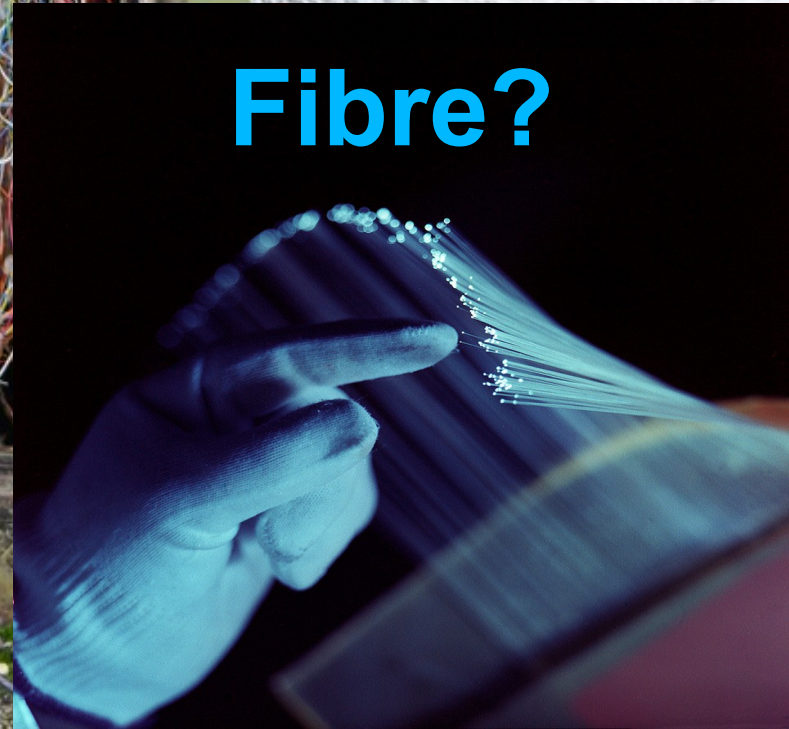


Wireless



Copper?

**Why Care
About
Spectrum?**



Fibre?

The Spectrum Crunch

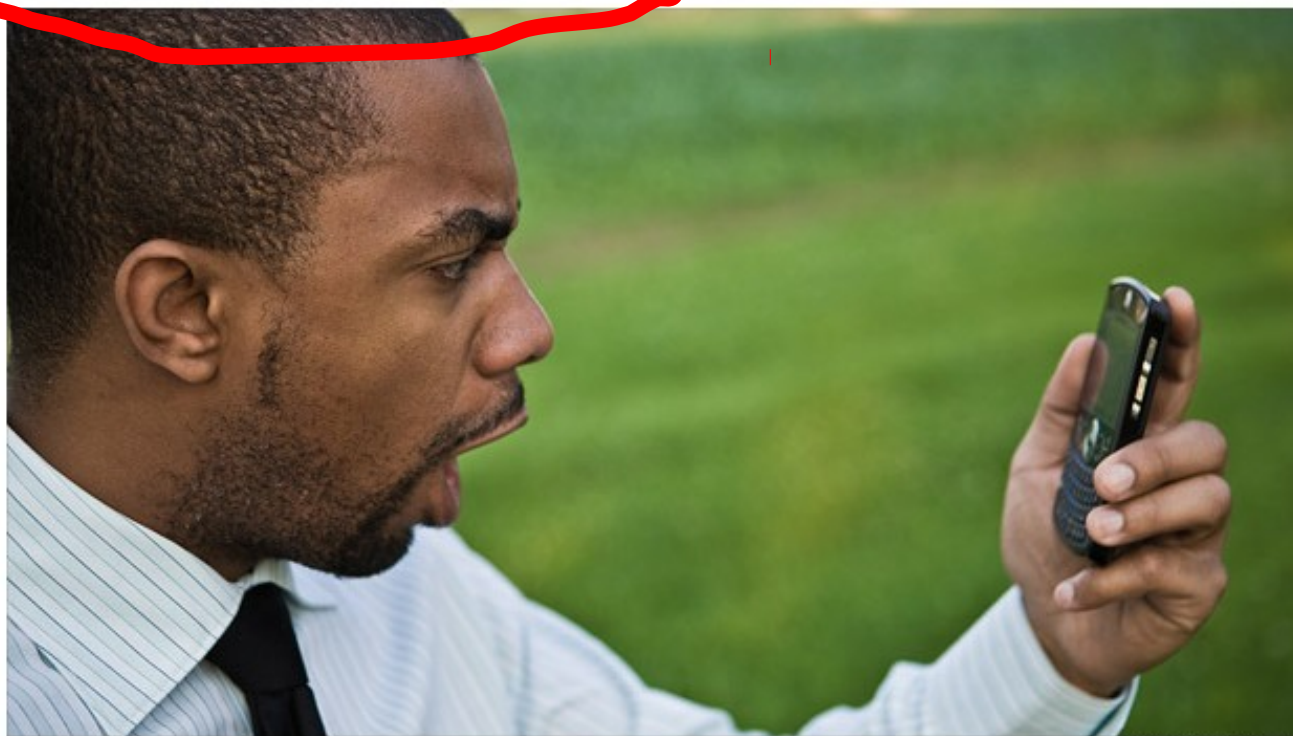


PHOTO: THINKSTOCK

America's wireless airwaves are full

The mobile phone industry is running out of capacity - and there's no quick or cheap fix. [More](#)

Most Popular

Boost for trade as glo

Someone bought a \$
Bitcoins

Five key numbers bel
recovery

2 million Facebook, G
passwords stolen in n

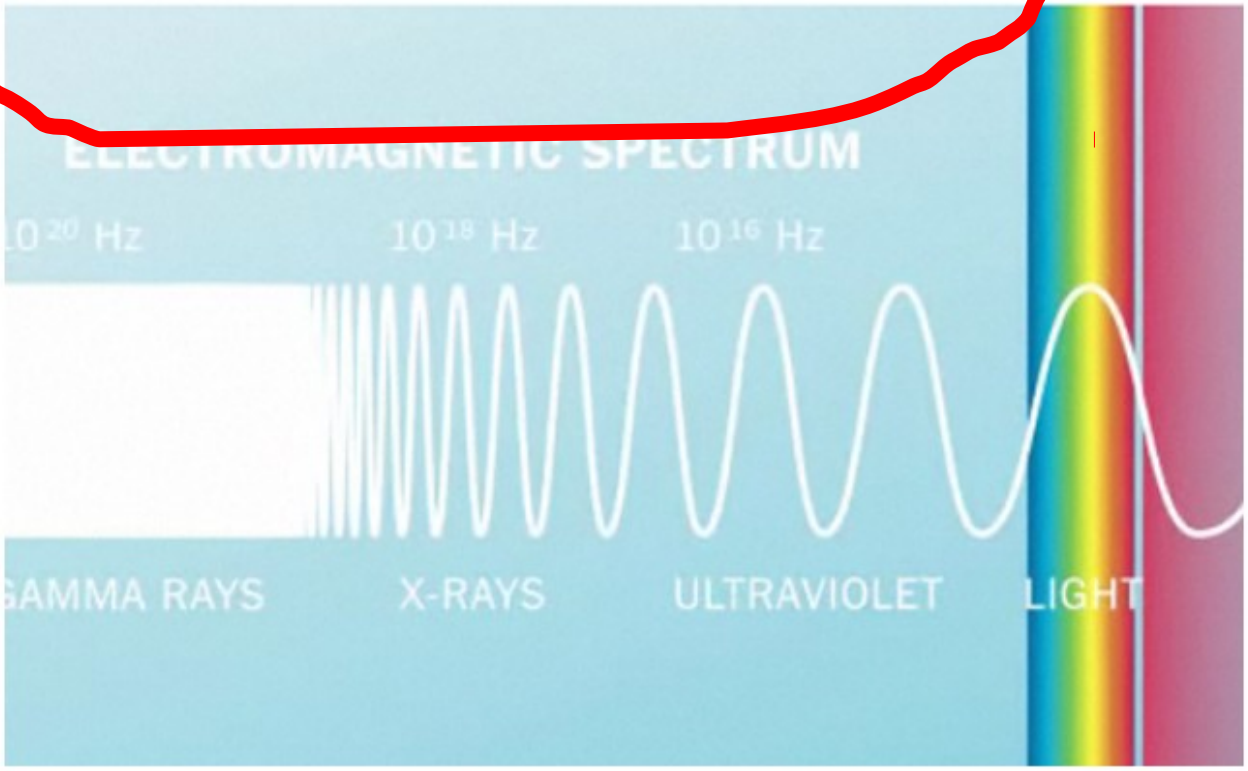
Where should you pu

APR 18, 2012 4:58PM ET / TECHNOLOGY

The Totally Made Up Spectrum Crisis

REBECCA GREENFIELD

364 VIEWS



NYTIMES

Wireless carriers are begging the government to give them more spectrum, claiming a coming shortage because of data-hungry cell-phone users. "The wireless carriers say that in the next few years they may not have enough of it to meet the exploding demands for mobile data," writes Brian X. Chen in *The New York Times*. "The result they ominously warn may be slower or spotty connections on

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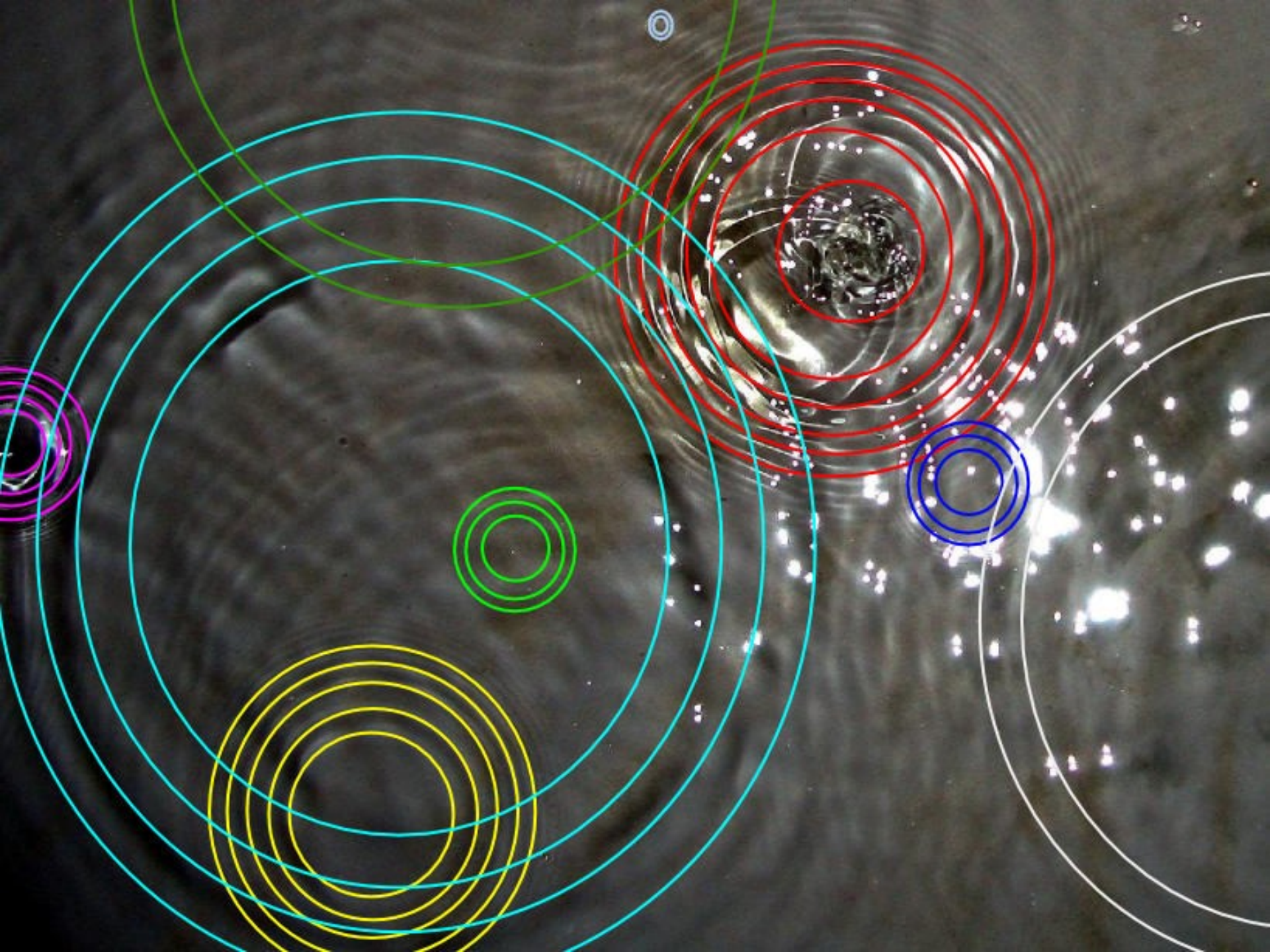


What Is Spectrum?

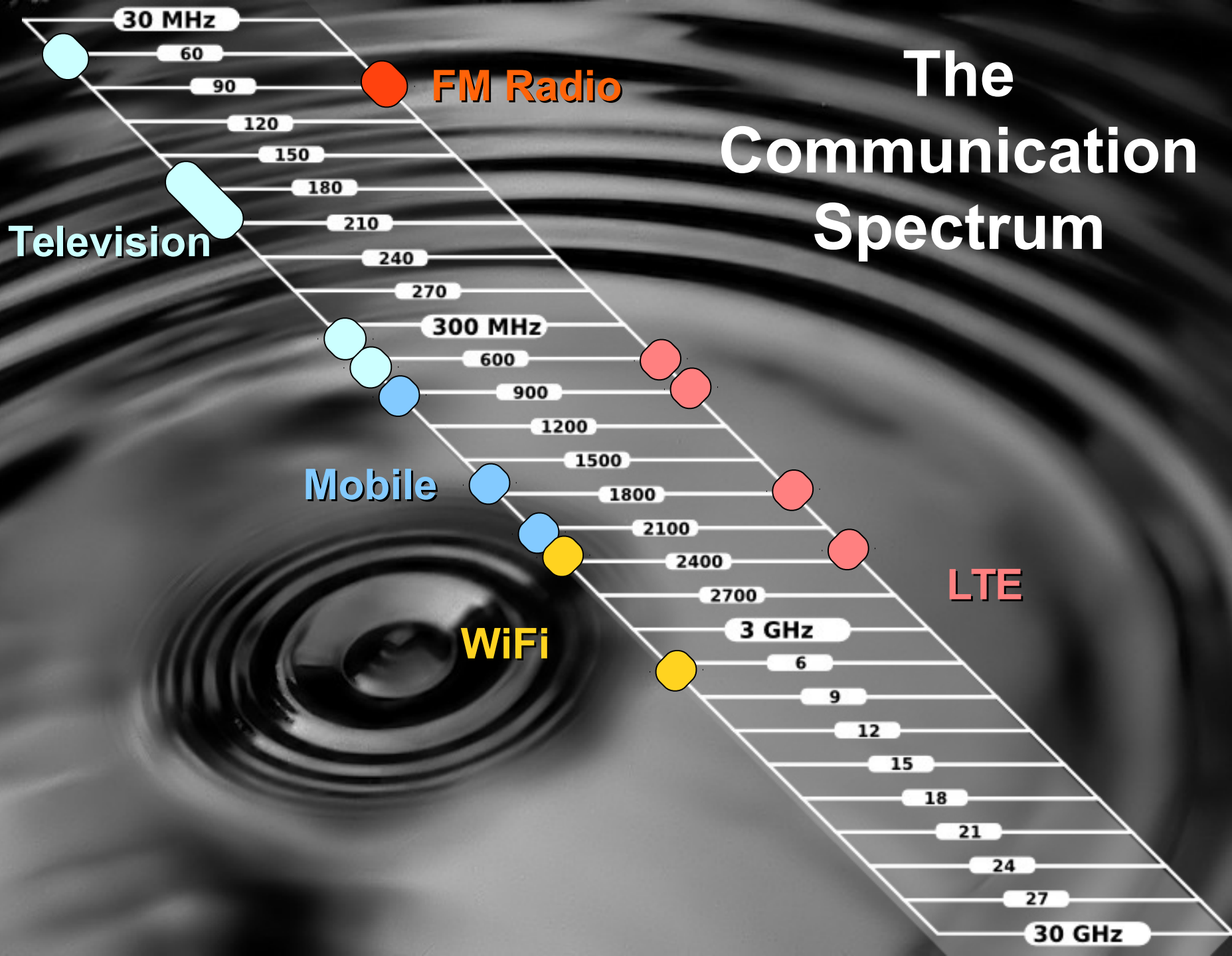
The background of the image is a dark, textured surface, possibly water, with several concentric ripples emanating from different points. The ripples are most prominent in the upper right and lower left quadrants. There are also numerous bright, shimmering light reflections scattered across the surface, particularly concentrated in the upper right area where they appear as a dense cluster of white and yellow points. The overall lighting is dim, creating a moody and abstract atmosphere.

**Why Does
Spectrum Need
To Be
Managed?**

Interference



The Communication Spectrum



**All Spectrum
Is Not Created
Equal**

More bandwidth per Hertz

Better Propagation

30 MHz

60

90

120

150

180

210

240

270

300 MHz

600

900

1200

1500

1800

2100

2400

2700

3 GHz

6

9

12

15

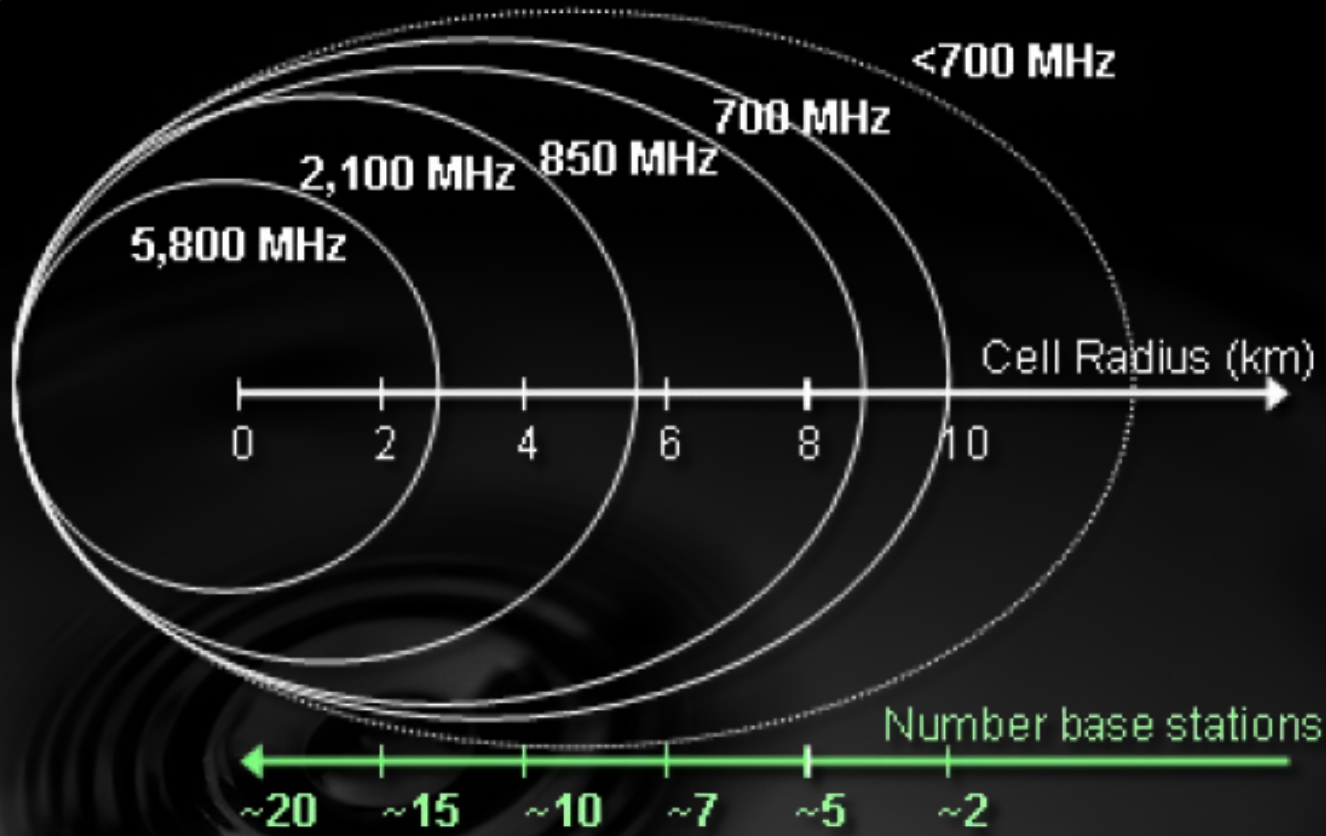
18

21

24

27

30 GHz

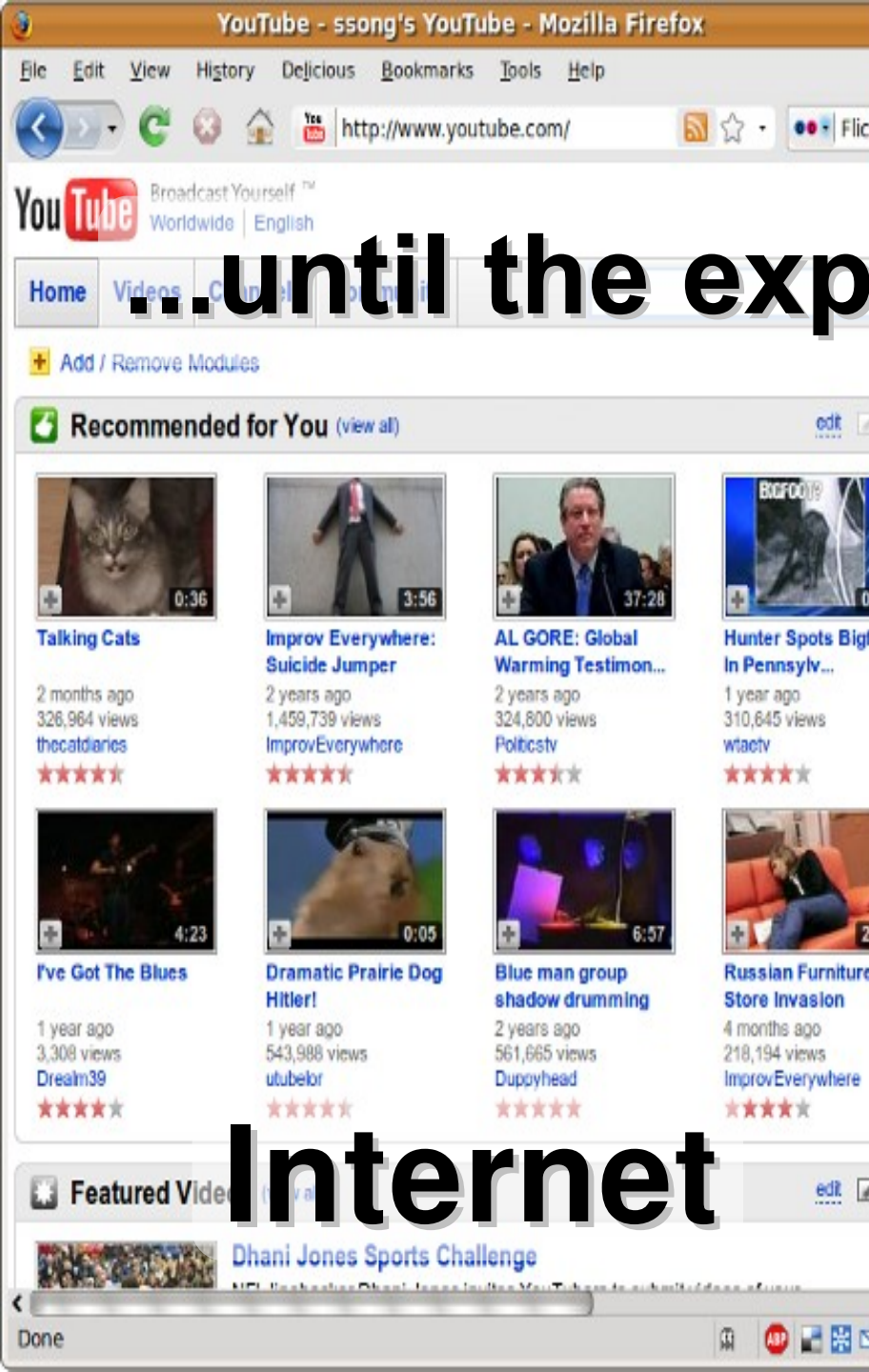


The propagation characteristics of spectrum

Source: BBC R&D.

**The core of
today's
spectrum
policy was
developed
in the early
20th century**

which was fine until...



...until the explosive growth of

Internet



Mobile

RESERVED SPECTRUM

**Unauthorized operators
will be towed / ticketed
at owners expense**



Administrative Barriers

BERRICE WOOD

BUREAUCRACY



Financial Barriers

Imagine a conference centre...



**..where each room might
correspond to a spectrum band.**

Or many conference centres...



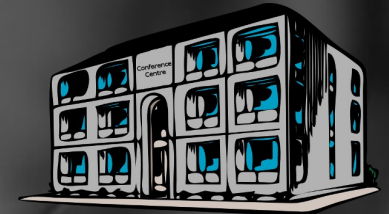
Lagos



Kano



Abuja



Access to any conference room A anywhere, anytime.



Lagos



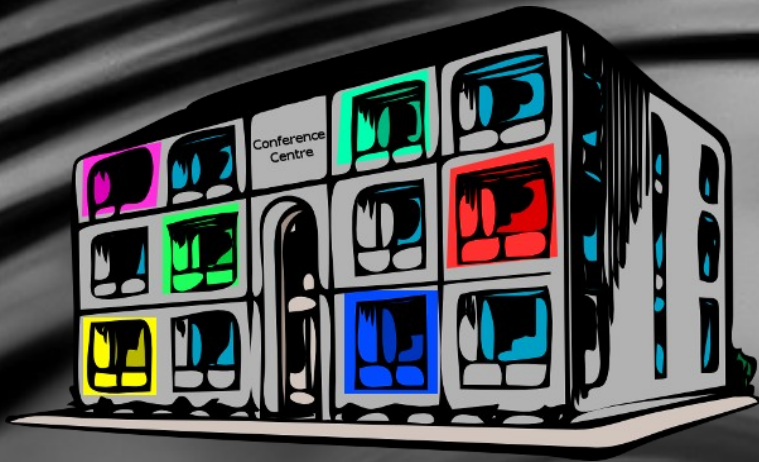
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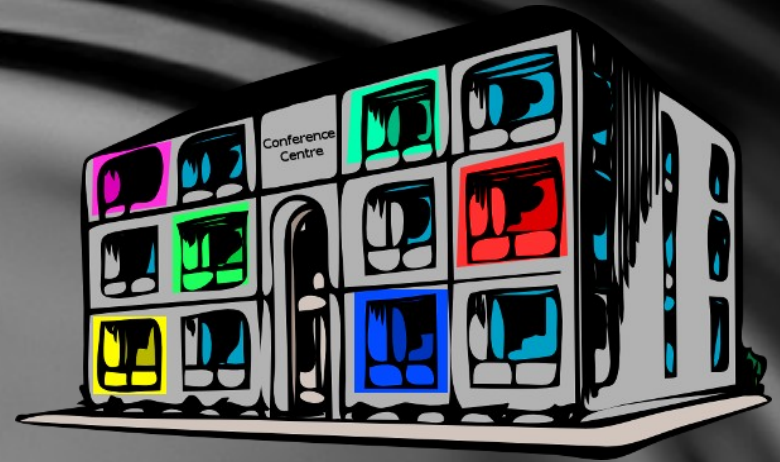
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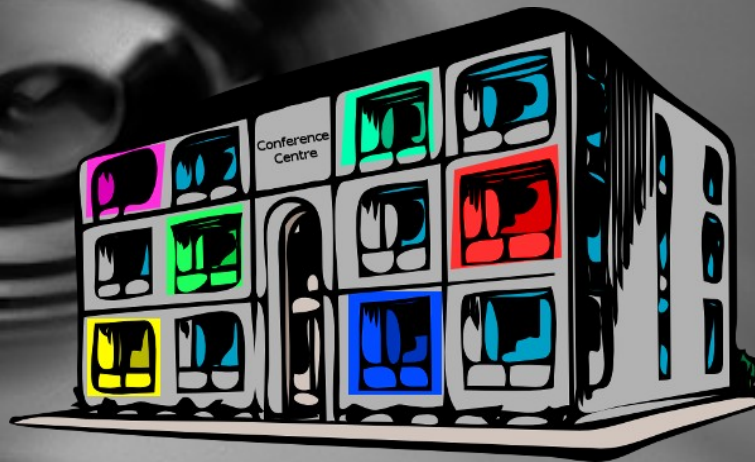
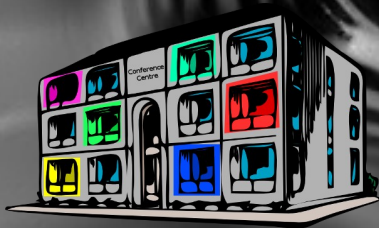
Spectrum is allocated like slices of a pie



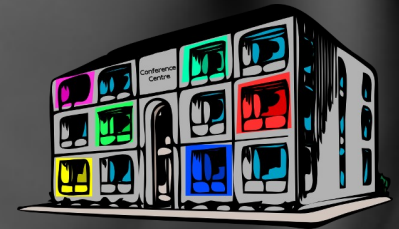
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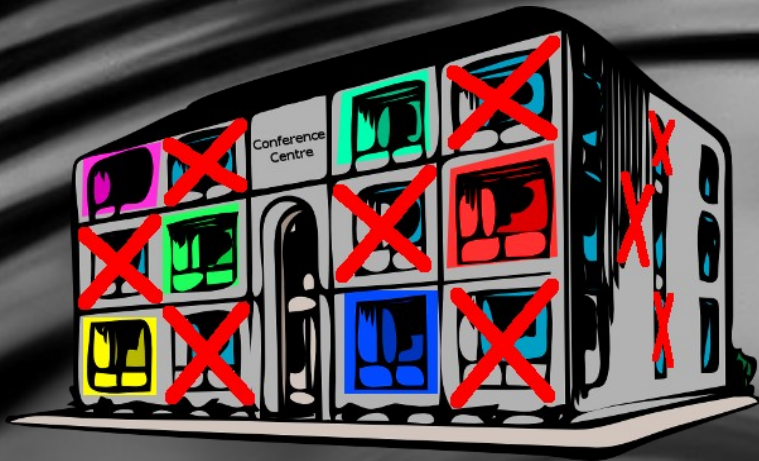
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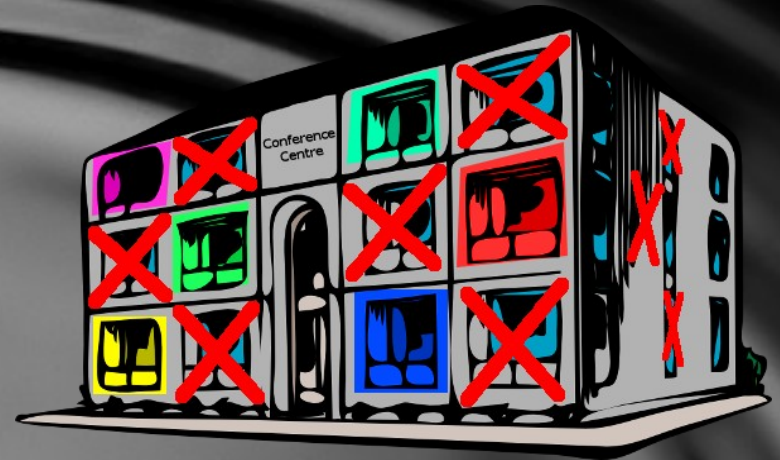
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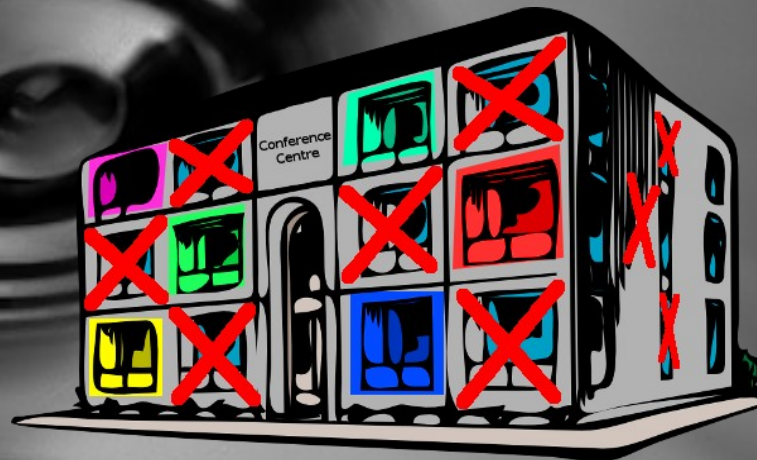
Guard bands



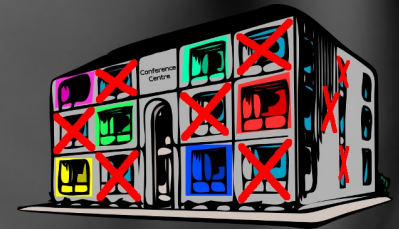
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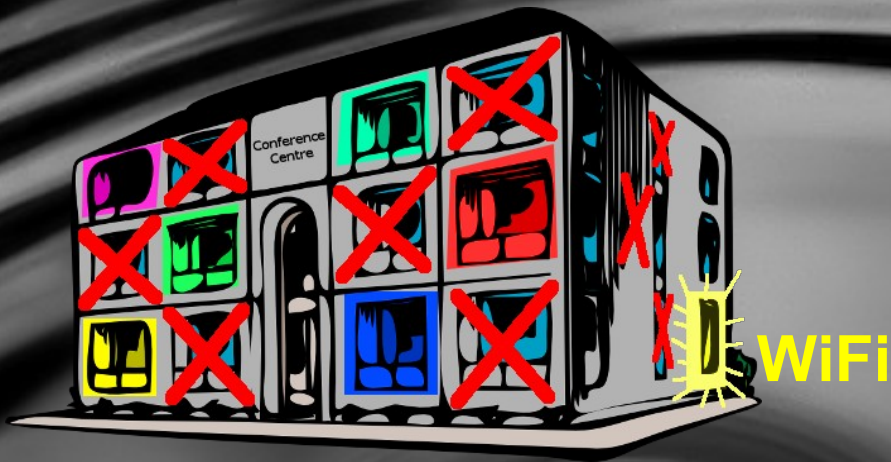
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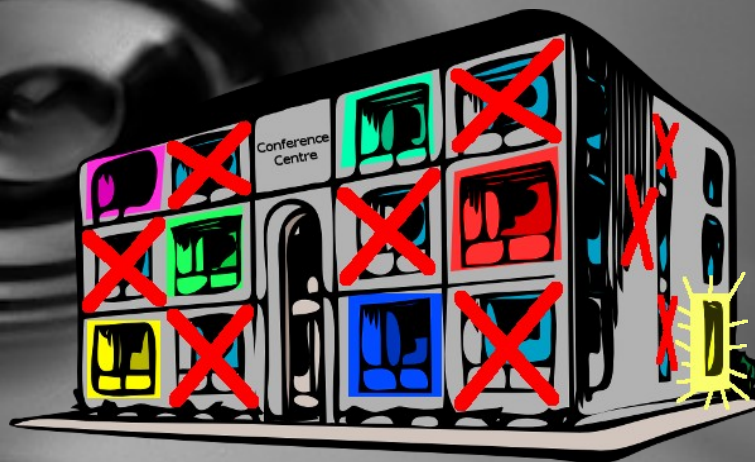
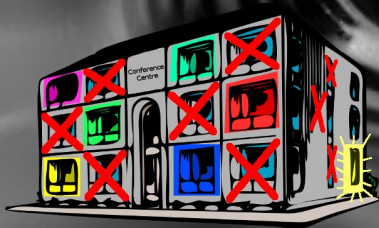
Unlicensed Spectrum



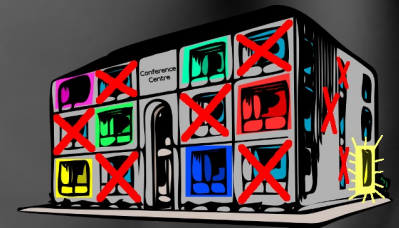
Lagos



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**How is spectrum
made available?**



Pros

- ✓ simple
- ✓ ok when supply exceeds demand

Cons

- ✓ potentially non-transparent
- ✓ breaks down as soon as demand increases

**Administrative Assignment
(first come, first serve)**

A black and white photograph of three women walking on a beach. They are wearing swimsuits and sashes, suggesting they are participants in a beauty pageant. The woman on the left has a sash that says "Miss 1970". The woman in the middle has a sash that says "Miss 1971". The woman on the right has a sash that says "Miss 1972". They are walking towards the camera, and the background shows a beach with people and a cloudy sky.

Pros

- ✓ ensure public interest outcomes

Cons

- ✓ prone to manipulation
- ✓ can lead to court challenges
- ✓ long administrative process

Beauty Contest



Pros

- ✓ neutral – market decides
- ✓ fair to all players
- ✓ can be designed for social outcomes

Cons

- ✓ can be gamed
- ✓ raises bar for market entry
- ✓ cost to consumer?

Auctions

Pros

- ✓ efficient
- ✓ no need to re-allocate spectrum
- ✓ wave of the future
– cognitive radio?

Cons

- ✓ interference?
- ✓ difficult to get incumbents to agree

Dynamic Spectrum



Digital Television

Digital Television

Television White Spaces

Mobile 700MHz

Mobile 800MHz

1 GHz

- Allows for the dynamic re-use of spectrum without interfering with the primary spectrum holder
- Ideal for rural access
- Low television spectrum occupancy in Africa

No re-allocation of spectrum required

Television White Spaces

Pros

- ✓ low barrier to entry
- ✓ spur to innovation
- ✓ spur for entrepreneurship

Cons

- ✓ conflict management
- ✓ no guarantees
- ✓ dependent on respect for standards

Unlicensed Spectrum (WiFi)



The Unlicensed Ecosystem



Distribution of Android smartphone-originated traffic across cellular and Wi-Fi networks, Jan 2013

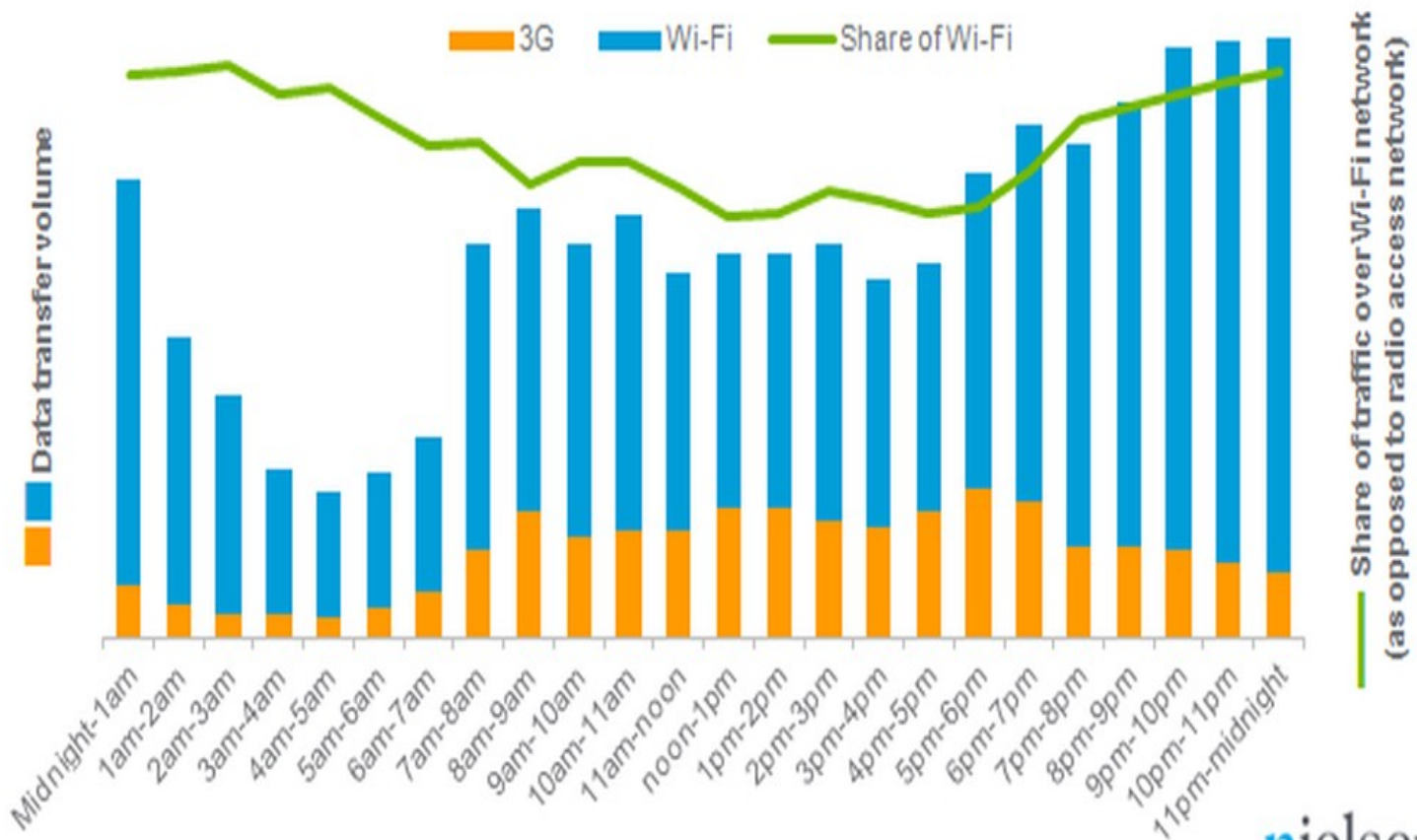
■ Cellular ■ Self-provisioned/ private Wi-Fi ■ Managed public Wi-Fi



Source: Mobidia

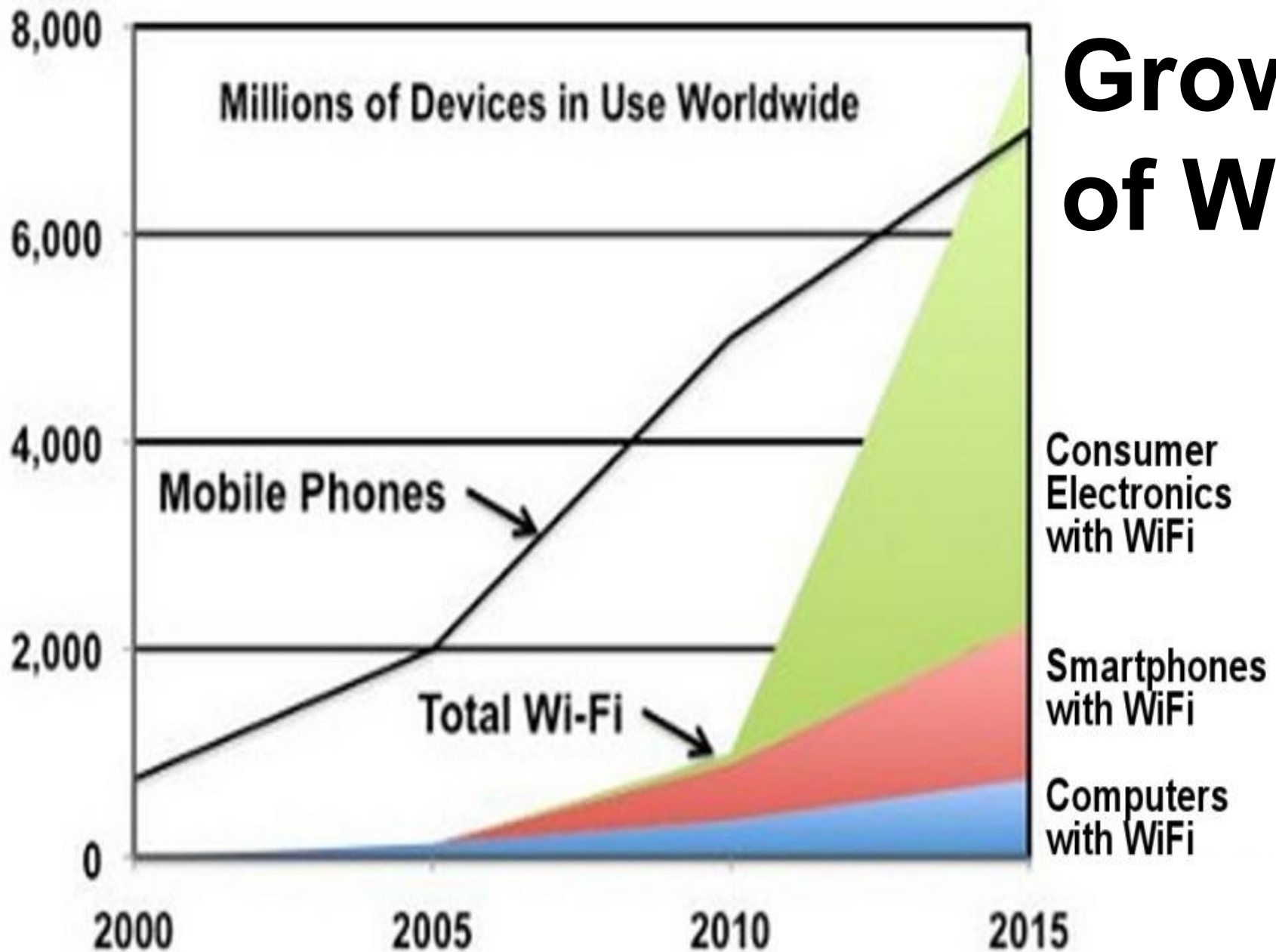
Wi-Fi delivers over three-quarters of all UK smartphone data

Mobile data transfer via Wi-Fi vs 3G by time of day (volume by hour)

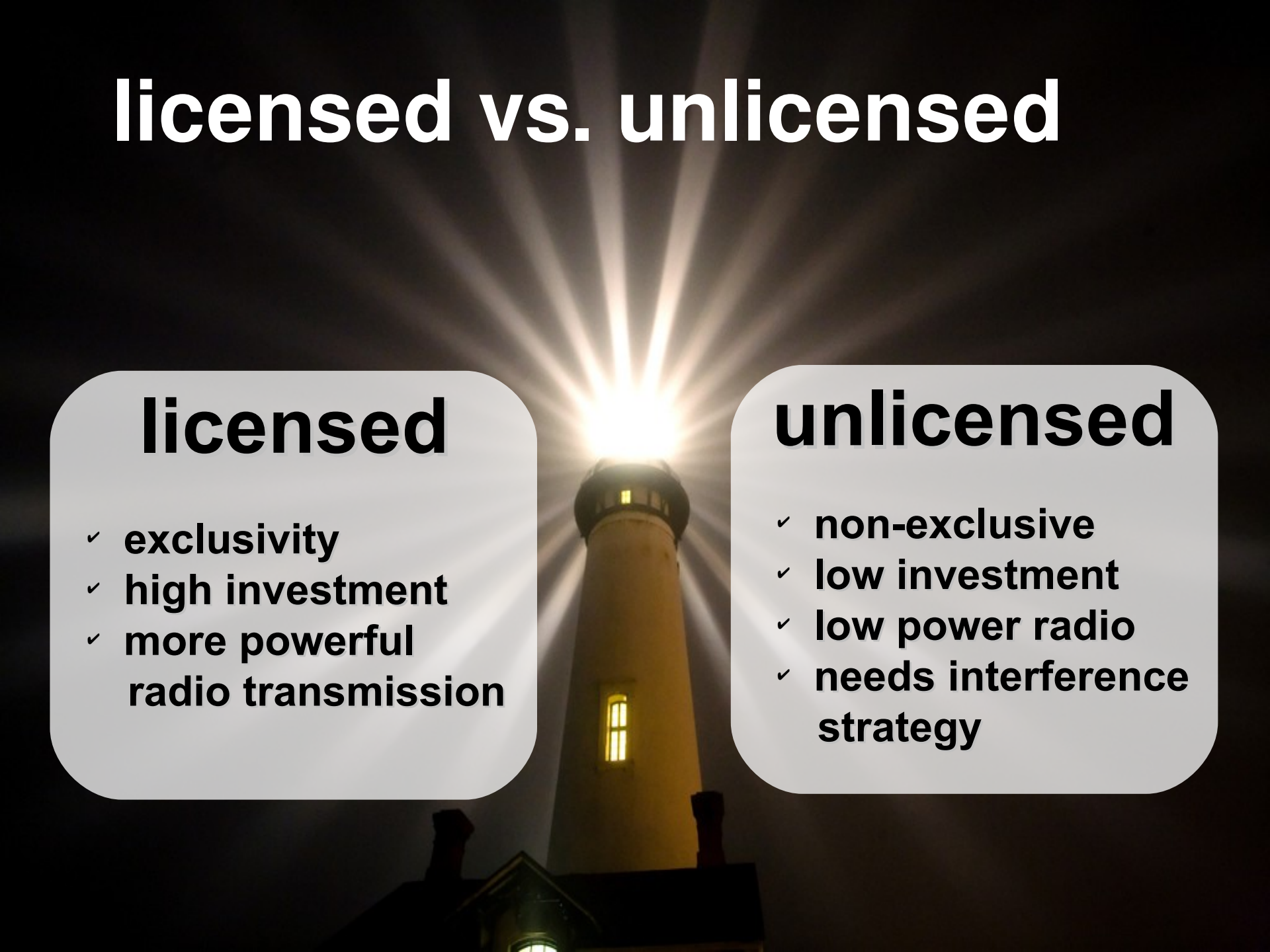


Source: Nielsen; 1-30 September 2012

Growth of WiFi



licensed vs. unlicensed




licensed

- ✓ exclusivity
- ✓ high investment
- ✓ more powerful radio transmission

unlicensed

- ✓ non-exclusive
- ✓ low investment
- ✓ low power radio
- ✓ needs interference strategy



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manypossibilities.net



Telephone box

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Beauty Contest

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King Farouk in the inauguration of the international telecommunications congress 1938 by KodakAgfa

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