



Spectrum Re-Farming: Framework and Methodology

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Based on Author's [Wiley Radio Spectrum Management: Policies, Regulations, Standards and Techniques](#) printed Aug16

*Dr. Haim Mazar; Vice Chair [ITU-R Study Group 5](#) (Terrestrial Services)
[ATDI Spectrum & Engineering](#)*

h.mazar@atdi.com & mazar@ties.itu.int; <http://mazar.atwebpages.com/>

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Video and Audio delivery & distribution

Analog or Digital

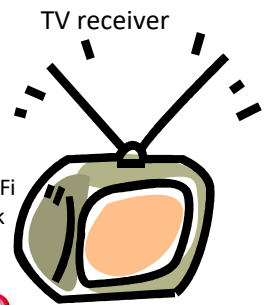


Terrestrial



VHF or UHF TV, or
AM, FM, digital... Audio

Return Channel (RC): over the air DVB-RC, via wired/WiFi
digital subscriber line (DSL), IMT or any other IP network



Off-air receiver

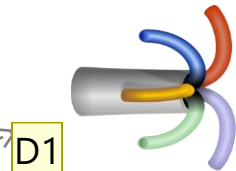


Handset using cellular
infrastructure for signaling

Broadcasting delivery and distribution



Broadcasting
Studio



D1

Cable



Video + Audio

Return Channel: over the air DVB-RC
or via the cable TV or wired/WiFi DSL



set-top box



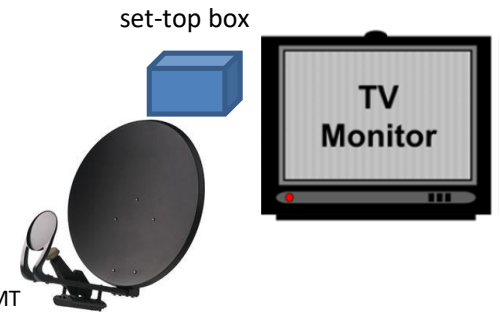
Direct-Broadcast Satellite
(DBS)



Video + Audio

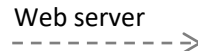
Return Channel
←

Over the air DVB-RC
(satellite or terrestrial)
or via wired/WiFi DSL or IMT



set-top box

Internet Protocol
Television (IPTV)



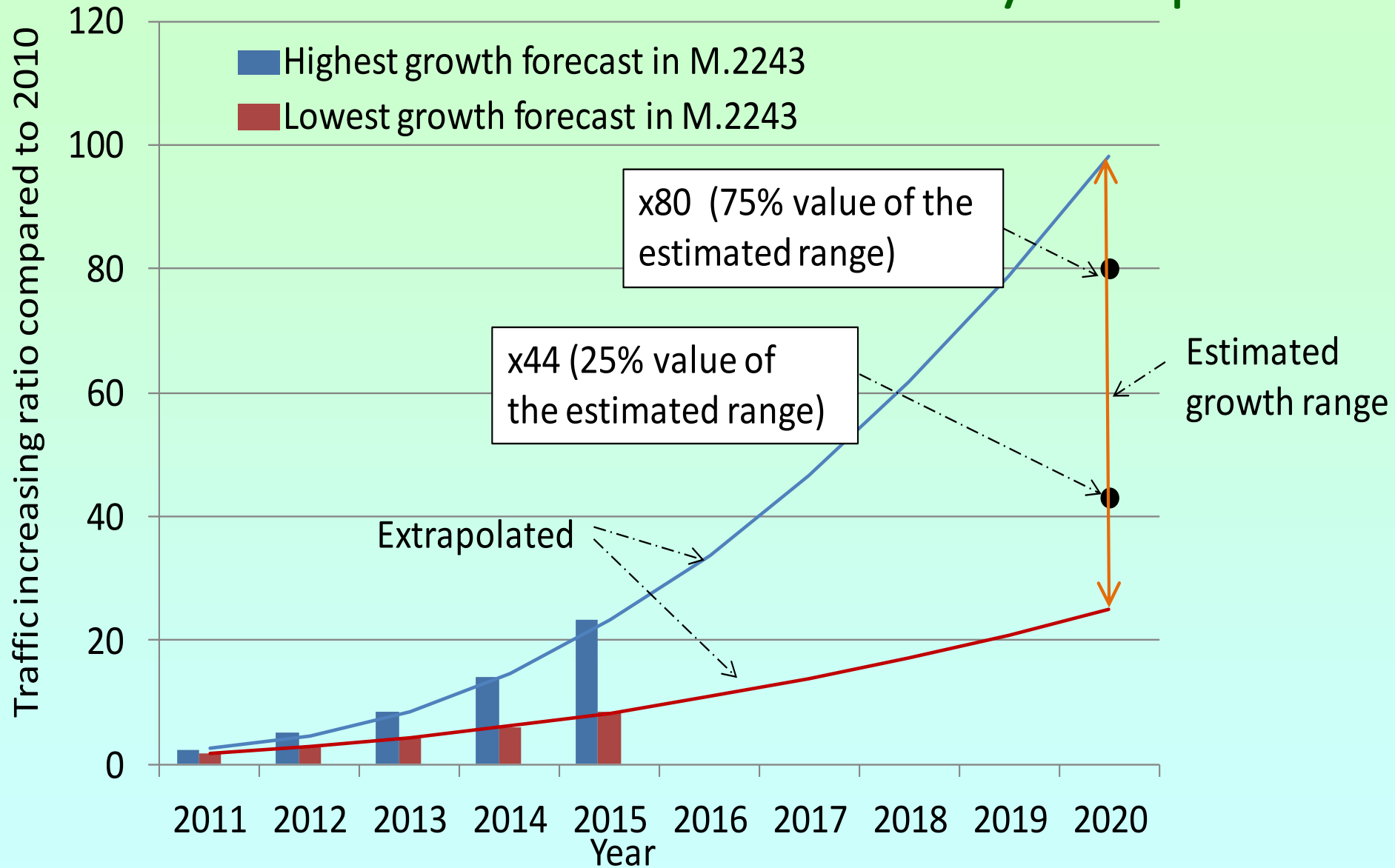
Web server

IPTV is a protocol through which TV is delivered over wirelines
(twisted pair / phone or coaxial cable / Cable TV)

Return Channel
←
Over the air DVB-RC or via wired/ WiFi
DSL or IMT over dedicated IPTV DSL



Mobile traffic forecasts toward 2020 by extrapolation



Re-Farming and Some Practices

Refarming is a process to govern the repurposing of spectrum bands to more efficient technologies and/or new services

Service continuity and investment are critical for successful Refarming

1. Set out the approach to **refarming** and **renewal** in advance (some 3–4 years prior to expiry) to avoid network investment being postponed
2. In the case of **renewal**, incumbent licensees may have the rights of first-refusal
3. Provide stability, certainty and transparency through long-term planning, i.e. develop spectrum roadmaps
4. Progressively technology restrictions in existing mobile spectrum usage rights
5. Introduce flexible regulatory tools, such as spectrum trading and sharing, to facilitate better spectrum utilisation
6. Evaluate spectrum value in a holistic approach; focus on long-term socio-economic impact

Design of a Competitive Tender or Auction

1. Draft rules for use of the spectrum: licence parameters; coverage and QoS obligations, bilateral and multilateral agreements; obligations relating to the mutual interference caused to/by other services in the band or in adjacent bands; **technology neutrality**
2. Technology neutrality allows for license holders to evolve their technology and the services delivered as markets develop
3. Clarification of the international situation: interference that may be caused to the notified licensed network in border areas, what are the commitments taken by the government to protect the services of other countries and those taken by other governments to protect the licensed network
4. Obligations to protect the public human hazards, against electromagnetic waves
5. Setting licence terms and conditions (e.g. fees, term limits, renewal criteria)
6. Setting auction rules
7. Publication: transparency, openness and responsiveness
8. Check for potential bidders' qualifications in terms of financing, operational experience in other countries, and management capabilities

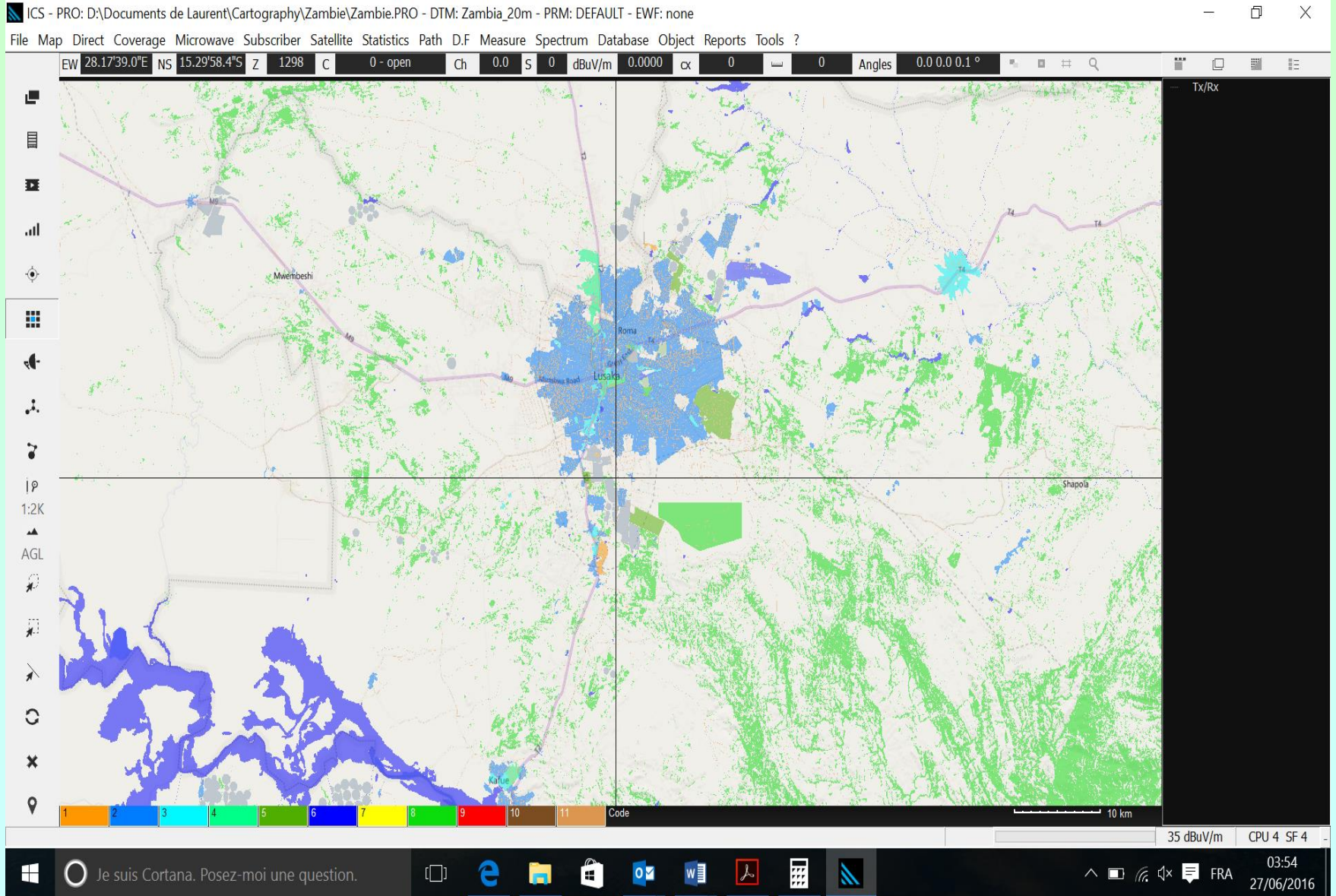
Methodology: Incentive Pricing

1. Fee is an indirect approximation of the market value
2. Fee formulas consist of relatively few and measurable elements, such as: allocated **bandwidth**, **RF** carrier
3. Objectives of incentive fees:
 - 1) Rent arising from the public or private use of a scarce common good
 - 2) Fostering and ensuring efficient use of spectrum by preventing operators from stockpiling spectrum that they don't really need
 - 3) Incentives to re-farm to less congested frequency bands, and use more spectrally efficient equipment

Methodology: Cost Orientation (or Cost Recovery)

1. Fees for RF licenses are set according to the costs associated with the management and administration of all related processes. Administration handles:
2. RF allocations to radio services
3. Assignment of licence and RF to Tx Stations
4. Fee collection: RF License & annual fees
5. Equipment Type approval
6. Coordination with neighbour countries (no borders to the ElectroMagnetic waves)
7. Notifying ITU to the Master International Frequency Register (MIFR) e.g. <http://www.itu.int/ITU-R/eBCD/ePub.aspx>
8. External relations: toward ITU, International and Regional orgs see <http://eprints.mdx.ac.uk/133/2/MazarAug08.pdf> p. 179
9. Use cartography to ease sharing

ATDI uses digital cartography of at 20 m. resolution for co-sharing

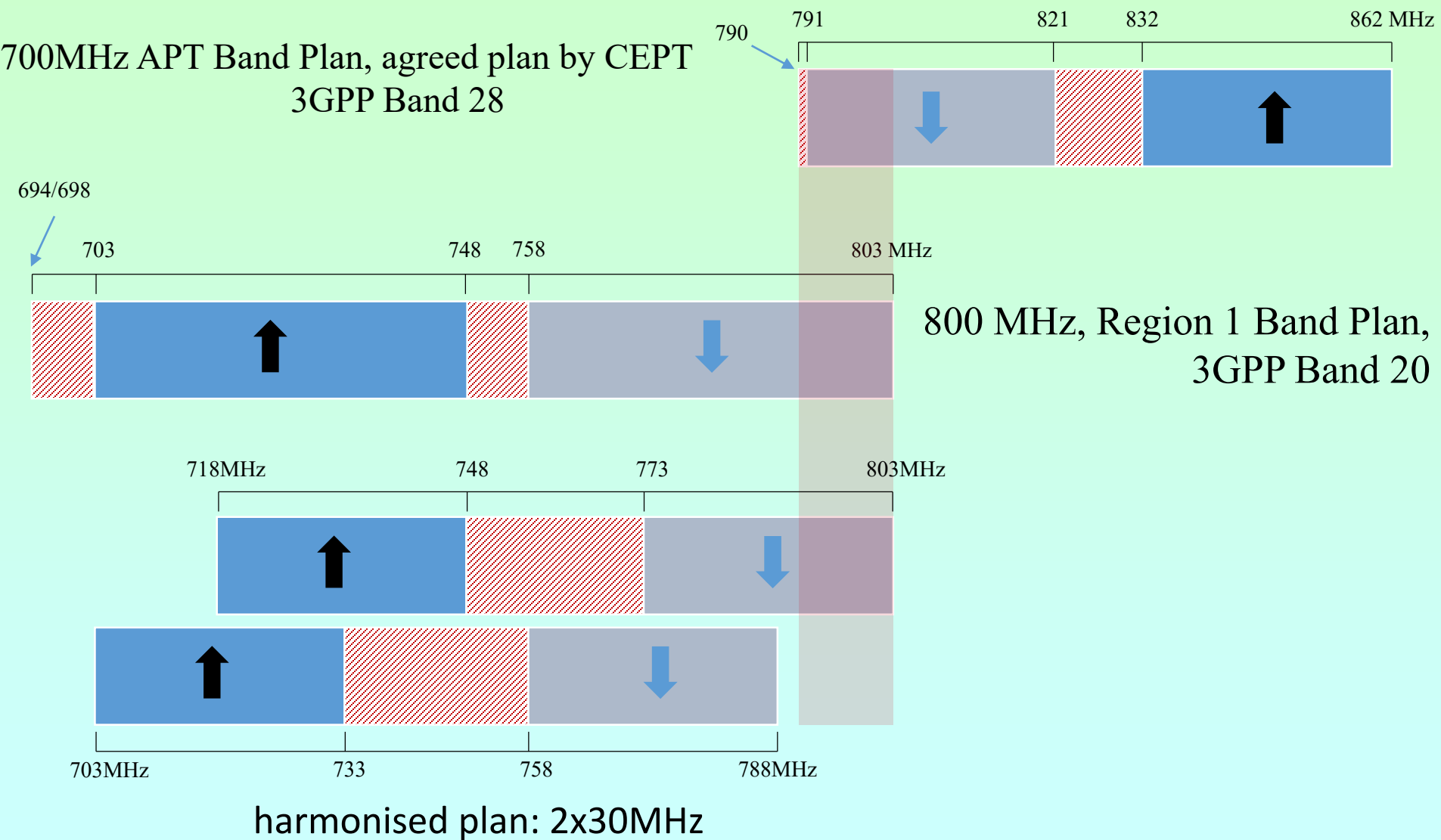


Recommended RF arrangements in bands identified for IMT-2000

1 Band 806-960 MHz ²											
MHz	800	825	850	875	900	925	950	975			
A1	MS Tx 824 849		BS Tx 869 894								
A2	MS Tx 880 915						BS Tx 925 960				
2 Band 1 710-2 025 MHz, 2 110-2 200 MHz											
MHz	1 700	1 750	1 800	1 850	1 900	1 950	2 000	2 050	2 100	2 150	2 200
B1			TDD MS Tx 1 880 1 920		TDD 1 980 2 010		TDD 2 010 2 025		BS Tx 2 110 2 170		
B2	MS Tx 1 710 1 785 [#]		BS Tx 1 805 1 880 [#]		# The upper limits in some countries are 1 755 and 1 850 MHz						
B3			MS Tx TDD BS Tx 1 850 1 910 1 930 1 990								
B4	MS Tx 1 710 1 785		BS Tx TDD MS Tx 1 805 1 880 1 920 1 980		TDD 2 010 2 025		BS Tx 2 110 2 170				
B5	MS Tx 1 710 1 770		MS Tx TDD BS Tx 1 850 1 910 1 930 1 990		BS Tx 2 110 2 170						
3 Band 2 500-2 690 MHz											
MHz	2 500	2 550	2 600	2 650	2 690						
C1	MS Tx 2 500 2 570		TDD 2 570 2 620		BS Tx 2 620 2 690						
C2	MS Tx 2 500 2 570		BS Tx (external) 2 570 2 620		BS Tx 2 620 2 690						
C3	Flexible FDD/TDD										

Rec ITU-R [M.1036](#)

Digital Dividends: 700/800MHz band plan (source GSMA)



Is RF a tangible asset? Is licence-fee a sale or a rent? What is its value?

If annual-fee AF remains the same in real term (not in nominal term, due to inflation) throughout the n periods, the cash flow Present Value (PV) of an annuity for n payment periods is the sum of the geometric series; where r equals the interest-rate compounded for each period of time, and n is the number of payment periods:

$$PV = AF + \frac{AF}{(1+r)^1} + \frac{AF}{(1+r)^2} + \dots + \frac{AF}{(1+r)^n} = \sum_{t=0}^n \frac{AF}{(1+r)^n} = AF \sum_{t=0}^n \frac{1}{(1+r)^n}$$

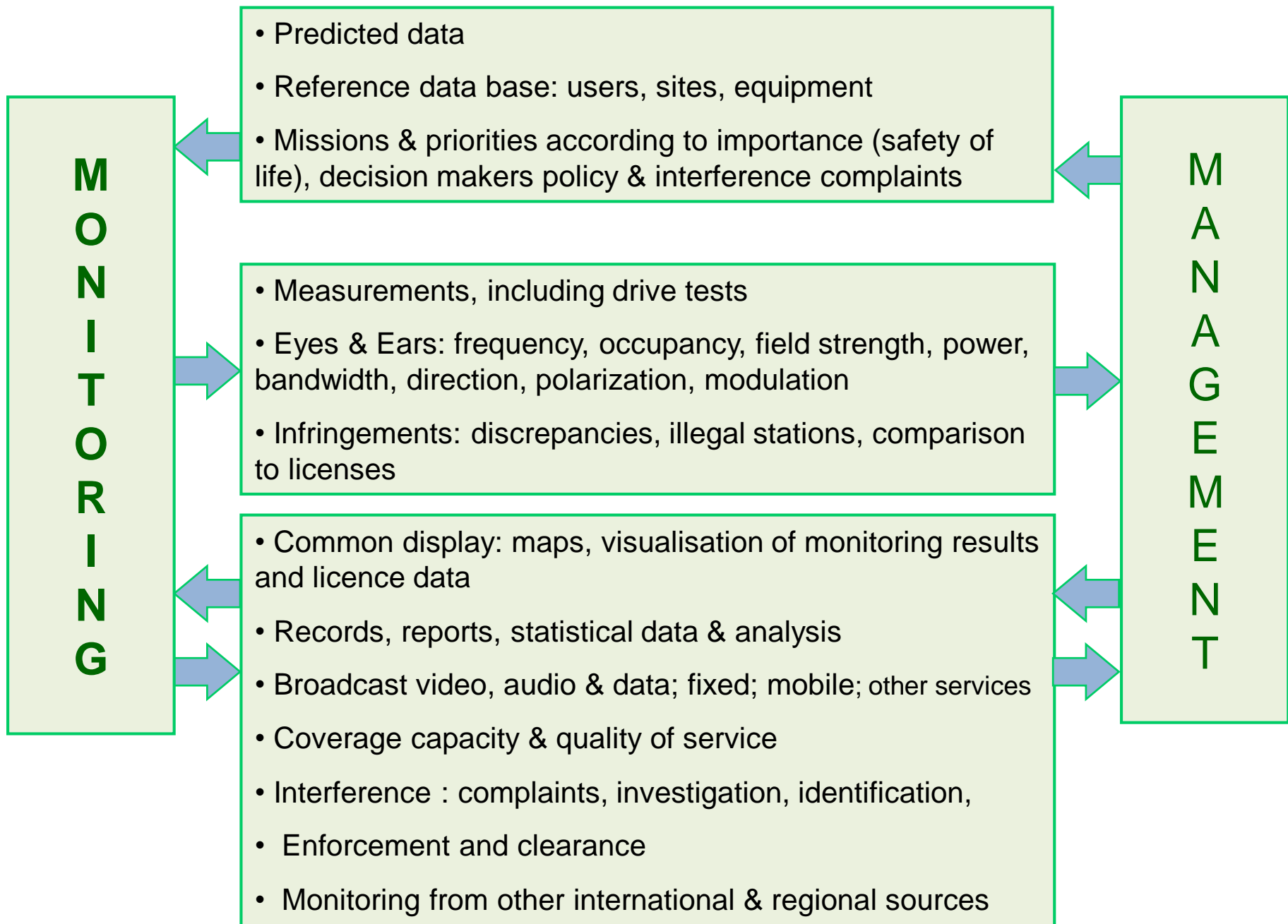
$$PV = AF \sum_{t=0}^n \frac{1}{(1+r)^n} = AF \frac{1+r}{r} \left(1 - \frac{1}{(1+r)^n}\right) \approx AF \frac{1}{r}$$

example: assume AF of \$30 million, typical annual discount rate (see French accounting) r of 4.0%, the present-value PV according to cost accounting of the RF equals $\frac{30 \times 10^6}{0.04} = \$750M$

ITU-D Resolution 9 Report Fig. 6: different types of auction



Interrelation of national spectrum management & monitoring functions



Theories and Policies: one way to manage RF

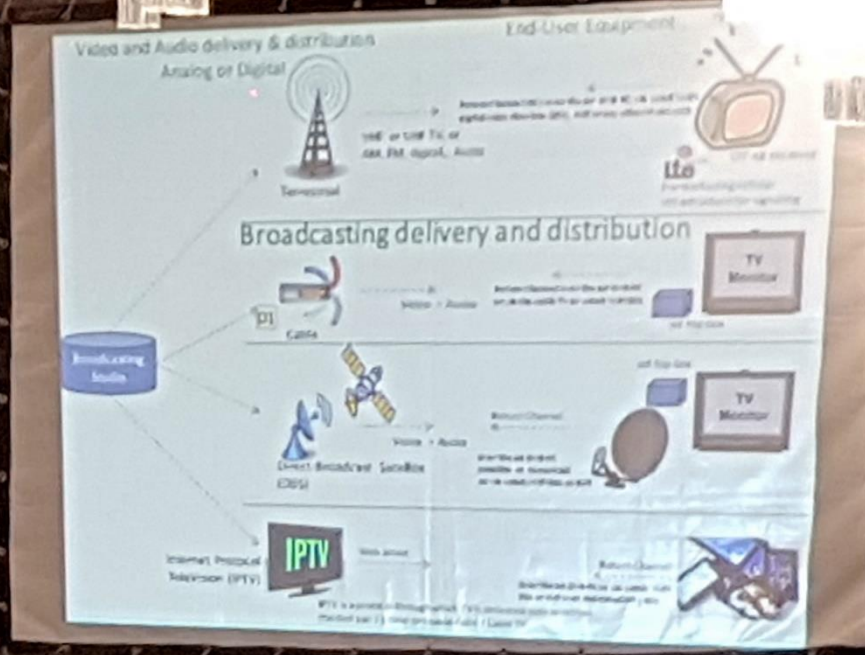
1. So begins Leo Tolstoy's *Anna Karenina* : 'All happy families are alike; each unhappy family is unhappy in its own way'
2. Between 2 points in planar geometry there is only one simple line, but indefinite curves
3. 'Great minds think alike' (Michaelian)
4. 'Stand on the shoulders of giants' (also I. Newton)
5. 'Okham's Razor': 'if you have to choose between competing theories, choose the simplest theory- it is most likely to be true'

Related author's publications & presentations

- [An Analysis of Regulatory Frameworks for Wireless Communications, Societal Concerns and Risk: the Case of Radio Frequency \(RF\) Allocation and Licensing](#) Boca Raton Florida: Dissertation.Com, 2009
- [A Comparison Between European and North American Wireless Regulations](#), presentation at the 'Technical Symposium at ITU Telecom World 2011' www.itu.int/worl2011 on 27 October 2011; hyperlink to the [slides presentation](#), 27 October 2011
- [Academic Course Engineering 2015.pdf](#); [Academic Course Services 2015.pdf](#);
[Academic Course Regulation EMC HumanHazards.pdf](#)
- More info at new Wiley book <https://www.amazon.com/Radio-Spectrum-Management-Regulations-Techniques/dp/1118511794>

Any Questions ?

**Spectrum Re-Farming:
 Framework and Methodology**



Dr. Haim Mazar

Yaoundé
 Cameroon

3 Nov. 16

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