

State of the art in spectrum sharing deployment worldwide

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Spectrum sharing

- Private LTE and 5G licensing
- Secondary use of MNO block licenses
- Dynamic Spectrum Access
- Spectrum sharing between terrestrial and non-terrestrial



Private LTE and 5G licensing

CBRS vs C-band auction in the US

Exclusivity and larger license areas: Exclusive use in larger license areas has a 4x premium over shared use – C-Band versus CBRS (427%)¹

Auction	Year	MHz	MHz	Result	\$/MHz Pop	Notes
C-Band	2021	3700	280	\$80.9b	\$0.94	Unencumbered spectrum
CBRS	2020	3500	70	\$4.6b	\$0.22	Maximum 30 MHz & combined with unlicensed

1

<https://www.fiercewireless.com/regulatory/lessons-from-spectrum-auctions-entner>



Finland

Bands¹

- 2300 – 2320 MHz (20 MHz)
- 24.25 – 25.1 GHz (850 MHz)

LTE

40

-

5G

n40

n258

Intended use

- Local 4G/5G networks are intended for local use, for example, at factories, ports, airports, shopping centres, power plants and mines for their own activities. Under certain conditions, these networks can also enable minor public telecommunications operations or fixed wireless access (FWA) connections.

Licenses

- Yearly frequency fee, based on the number of frequencies and other grounds for fees².

Allocation

- Initially beauty contest. Continuous allocation by first-come-first-served

Protection

- Yes

¹ <https://www.traficom.fi/en/communications/communications-networks/local-4g5g-networks>

²

<https://www.traficom.fi/en/communications/communications-networks/frequency-fees-radio-reservation-and-radio-license>



France

Bands ¹	LTE	5G
<ul style="list-style-type: none">2570 - 2620 MHz (50 MHz)	41	n38
Intended use		
<ul style="list-style-type: none">Professional networks for companies and organizations, also called "verticals". They can remain operational even in the event of a major crisis. They can be deployed either to ensure the security of a site, or as a business tool for companies wishing to have a tailor-made communication system, for example for the management of passenger transport networks, water or energy and the internet of things.		
Licenses		
<ul style="list-style-type: none">?		
Allocation		
<ul style="list-style-type: none">Initially beauty contest. Continuous allocation by first-come-first-served.		
Protection		
<ul style="list-style-type: none">Yes		
¹ https://www.arcep.fr/demarches-et-services/professionnels/transformation-numerique-des-entreprises/guichet-frequences-2-6-tdd.html		



Bands¹

- | | LTE | 5G |
|-------------------------------|-----|----------|
| • 3700MHz - 3800MHz (100 MHz) | 43 | n77, n78 |
| • 24.25 – 27.5 GHz (3250 MHz) | - | n258 |

Intended use

- Not specified

Licenses

- Yearly frequency fee, based on the number of frequencies and other grounds for fees².

Allocation

- Initially beauty contest. Continuous allocation by first-come-first-served.

Protection

- Yes

1

https://www.bundesnetzagentur.de/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Frequenzen/OeffentlicheNetze/LokaleNetze/lokalenetze-node.html

https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/EN/2019/20191031_LokalesBreitband.html

Netherlands

Bands¹

- 3410 - 3800MHz (390 MHz)

LTE

42, 43

5G

n77, n78

Intended use

- Company in an industrial area with insufficient internet capacity available and private business areas where you want to use mobile broadband communication.

Licenses

- ?

Allocation

- Initially beauty contest. Continuous allocation by first-come-first-served.

Protection

- Yes

1

<https://www.agentschaptelecom.nl/onderwerpen/internetverbinding-verbeteren/documenten/formulieren/2017/april/4/aanvraag-vergunning-frequentieruimte-lokaal-breedbandnetwerk>
https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/EN/2019/20191031_LokalesBreedband.html



Sweden

Bands¹

- 3720MHz - 3800MHz (100 MHz)
- 24.25 – 25.1 GHz (850 MHz)

LTE

43

-

5G

n77, n78

n258

Intended use

- Different applications, for example industries, mines, ports, warehousing and hospitals.

Licenses

- ?

Allocation

- Initially beauty contest. Continuous allocation by first-come-first-served.

Protection

- Yes

1

<https://pts.se/sv/dokument/remisser/radio/2021/remiss-avseende-forslag-till-villkor-for-lokala-tillst-and-i-35-ghz--och-26-ghz-banden/>



UK

Bands¹

	LTE	5G
• 1781.7-1785 & 1876.7-1880 MHz (2 x 3.3 MHz)	3	n3
• 2390-2400 GHz (10 MHz)	40	n40
• 3.8 - 4.2 GHz (400 MHz)	-	n77, n78
• 24.25 – 26.5 GHz (2250 MHz)	-	n258

Intended use

- Range of sectors, such as manufacturing, enterprise, logistics, agriculture, mining and health.

Licenses

- Annual licence fee: the low power licence (charged on a per area basis) and medium power licence (charged on a per base station basis).

Allocation

- Initially beauty contest. Continuous allocation by first-come-first-served.

Protection

- Yes

1

https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf



Secondary use of MNO block licenses



Bands¹

- 3410 – 3800 MHz (390 MHz)

LTE

42, 43

5G

n77, n78

Intended use

- If MNO does not serve a customer specific network to port, industrial site, hospital, shopping center or similar, MNO has to lease the spectrum to the operator deploying such a network.

Finland

1

https://www.lvm.fi/documents/20181/1023292/VN_27408_2020-LVM-1+Toimilupap%C3%A4%C3%A4t%C3%B6s+ja+toimiluvat+3%2C5+GHz++1242260_1_1.PDF/aca5e4b2-bfcc-3013-ab3b-04d2bf2c1302?t=1607595960402



Denmark

Bands ¹	LTE	5G
<ul style="list-style-type: none">• 3740 - 3800MHz (60 MHz)	43	n77, n78
Intended use		
<ul style="list-style-type: none">• Actors other than the mobile operators, such as companies, public institutions and universities, the right to lease frequencies from the block license holder for the purpose of establishing private 5G networks.		

1 https://ens.dk/sites/ens.dk/files/Tele/information_memorandum_1.pdf



UK

Bands¹

- All MNO bands?

LTE

Many

5G

Many

Intended use

- Provide a simple process for MNOs to share access to their licensed but unused spectrum with other users.

1

https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf

Outside Europe

Hong Kong

- 27.95-28.35GHz (400 MHz)

Japan

- 4.6-4.8 GHz
- 28.2-29.1 GHz

USA

- CBRS 3550 - 3700 MHz (GAA and auctioned)
- C-band 3700 - 3980 MHz (auctioned)



Dynamic Spectrum Access (DSA)

Comparison of DSA systems

	LSA	eLSA	CBRS PAL	CBRS GAA	TVWS	AFC
Licensed and protected	Yes	Yes	Yes	No	No	No
Number of spectrum users	Few	Many	Many	More than PAL users	Many	Very many
Number of communicating entities	Few	Many	Many	More than PAL users	Many	Very many
Communication topology	VPN or server	Server	Server	Server	Server	Server
Operating params or restrictions	Both	Both	Oper params	Oper params	Oper params	Oper params
Frequency of changes	N.N.	N.N.	1 min	1 min	10 min - 1 h	24 h
Aggregate or per device interference	Aggregate	Aggregate	Aggregate	Aggregate	Per device	Per device
SOON and Co-existence	SOON	FCFS	CX CBRS Alliance	CX CBRS Alliance	CX IEEE 802.19.1	CX IEEE 802.19.1
Sensing	No	No	ESC	ESC	US on paper	No
Propagation model	ITU	ITU	FCC	FCC	ITU or FCC	FCC
Device standard	3GPP	3GPP	3GPP	3GPP	Proprietary	IEEE 802.11
Automatic and manual entry	N.N.	N.N.	Automatic	Automatic	Automatic and manual	Automatic
Need for DSA	PMSE, PPDR, Mil	PMSE, PPDR, Mil	Military	Military	PMSE	Consumers
Centralized or distributed	Central or distributed	Central	Central	Central	Central	Central

US Mid-band for private LTE/5G

CBRS (PAL auction and GAA 2020)

- DSA with SAS and ESC
- 3550-3700 MHz

C-band (Auctioned 2021)

- Static allocations
- 3700-3980 MHz

Band 3100-3550 MHz (Future)

- Static allocations
- Reservations and IIS 3450-3550 MHz

CEPT: LSA testing and implementation

Testing¹

- Spain (October 2015)
- Italy (November 2016)
- France (October 2016)
- Finland (March 2016)
- The Netherlands (update April 2019)
- Portugal (March 2019)

Implementation¹

- The Netherlands (April 2019)

¹ <https://www.cept.org/ecc/topics/lsa-implementation>

TVWS regulation

Europe

- UK

North America

- Canada
- USA

Latin America

- Colombia
- Trinidad and Tobago

Africa

- Botswana
- Ghana
- Kenya
- Malawi
- Mozambique
- Nigeria
- South Africa
- Uganda

Asia

- Philippines
- Singapore

Wi-Fi6 Automated Frequency Coordination (AFC)

Europe

- 5925-6425 MHz low power indoor and very low power indoor and outdoor

USA (and Canada)


- 5925 - 7125 MHz low power operations
- 5.925-6.425 GHz and 6.525-6.875 GHz standard power with AFC

Other countries

- Several other countries have adopted the full 1200 MHz band (5925 - 7125 MHz), but they have not yet decided about standard power and AFC


<https://www.rsm.govt.nz/assets/Uploads/documents/consultations/2021-wlan/wlan-use-in-the-6-ghz-band-discussion-document.pdf>

Spectrum reservations (Netherlands)



www.isanl.com
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[Learn more...](#)

Share Location ▾



Agentschap Telecom
Ministerie van Economische Zaken

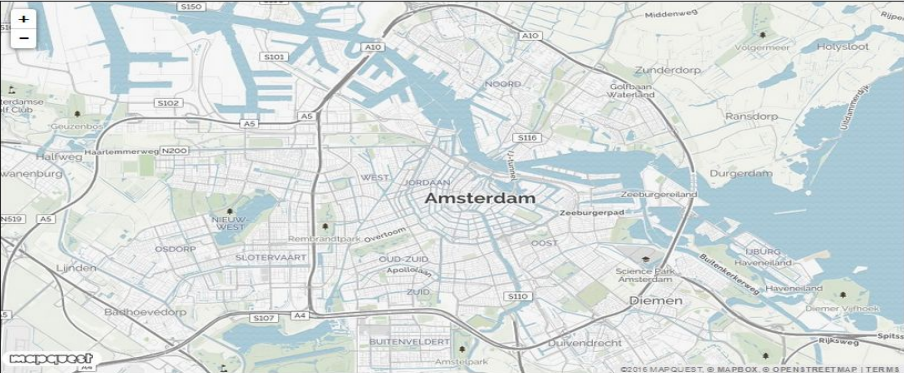
Log out

New reservationMy reservationsReservations and BlockingsChange ProfileDocumentation

New reservation

LatitudeLongitudeCoverage (meters)

1000



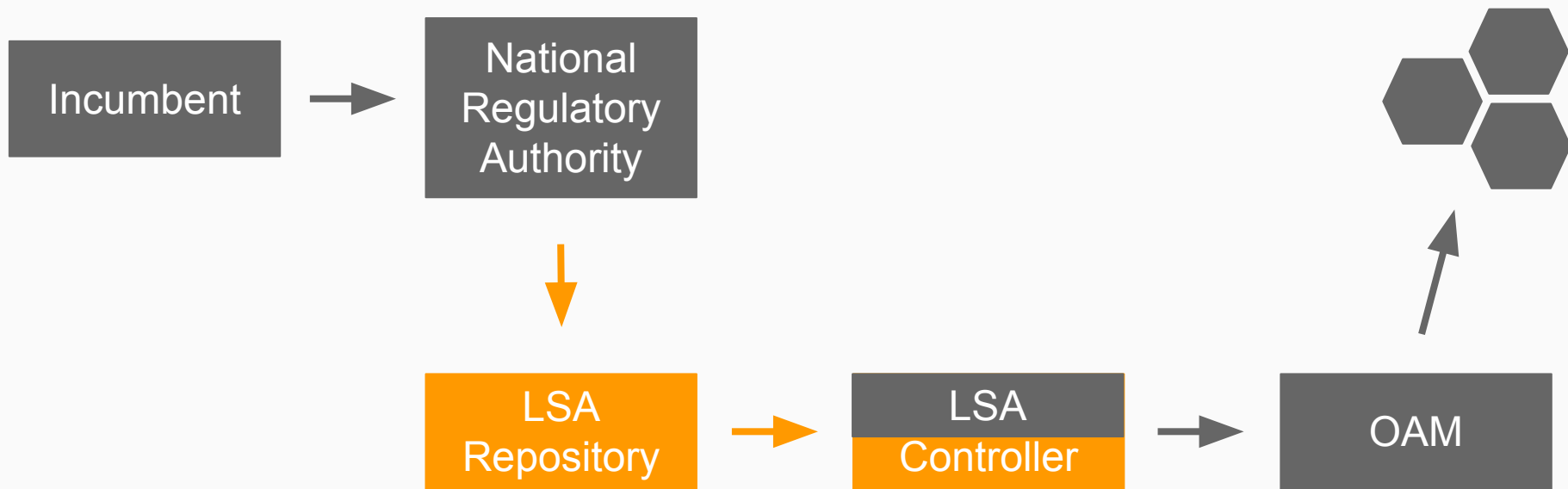
A detailed map of Amsterdam, Netherlands, showing the city's layout with its characteristic canals and bridges. The map is centered on the city of Amsterdam, with labels for various districts and landmarks. The map is interactive, with a zoom-in (+) and zoom-out (-) button in the top-left corner. The map is overlaid with a grid of latitude and longitude lines. The map is titled 'Amsterdam' in the center. The map is surrounded by a red border.

Start Date and Time

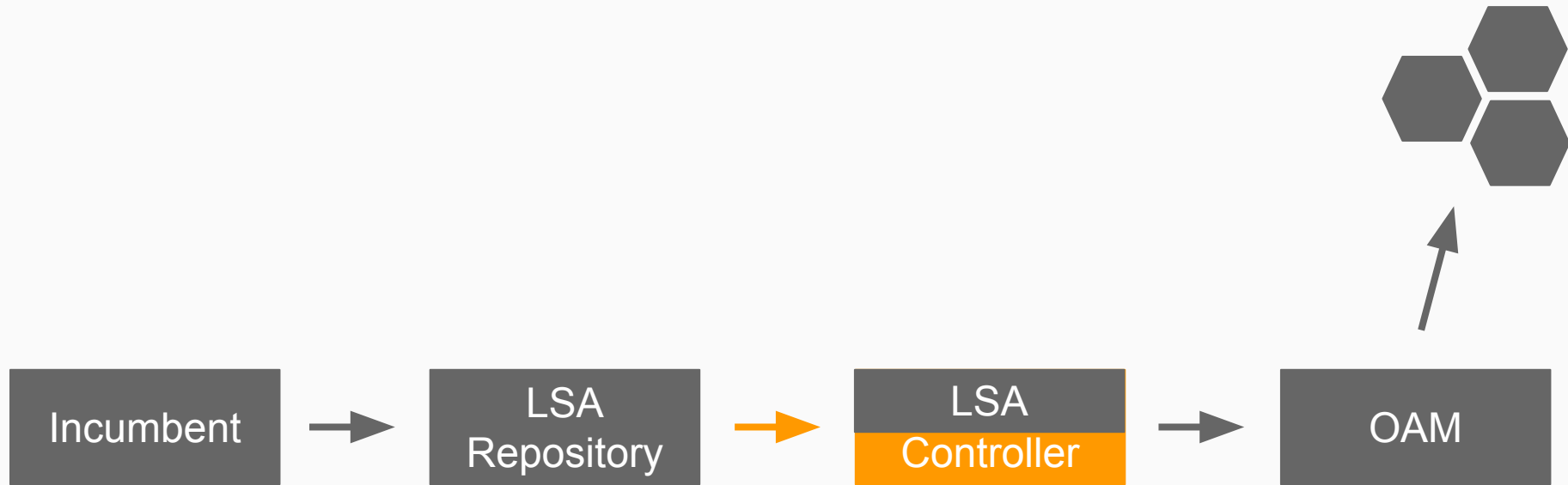
2016-09-1415:00

E.g., 2016-09-14E.g., 15:00

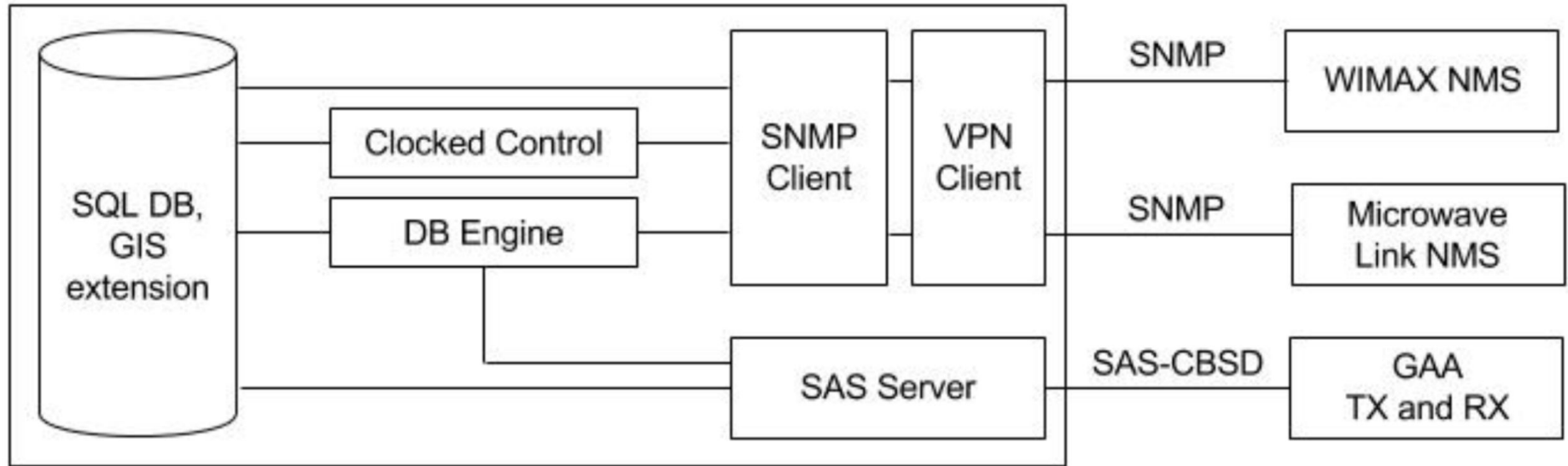
LSA Russia Architecture



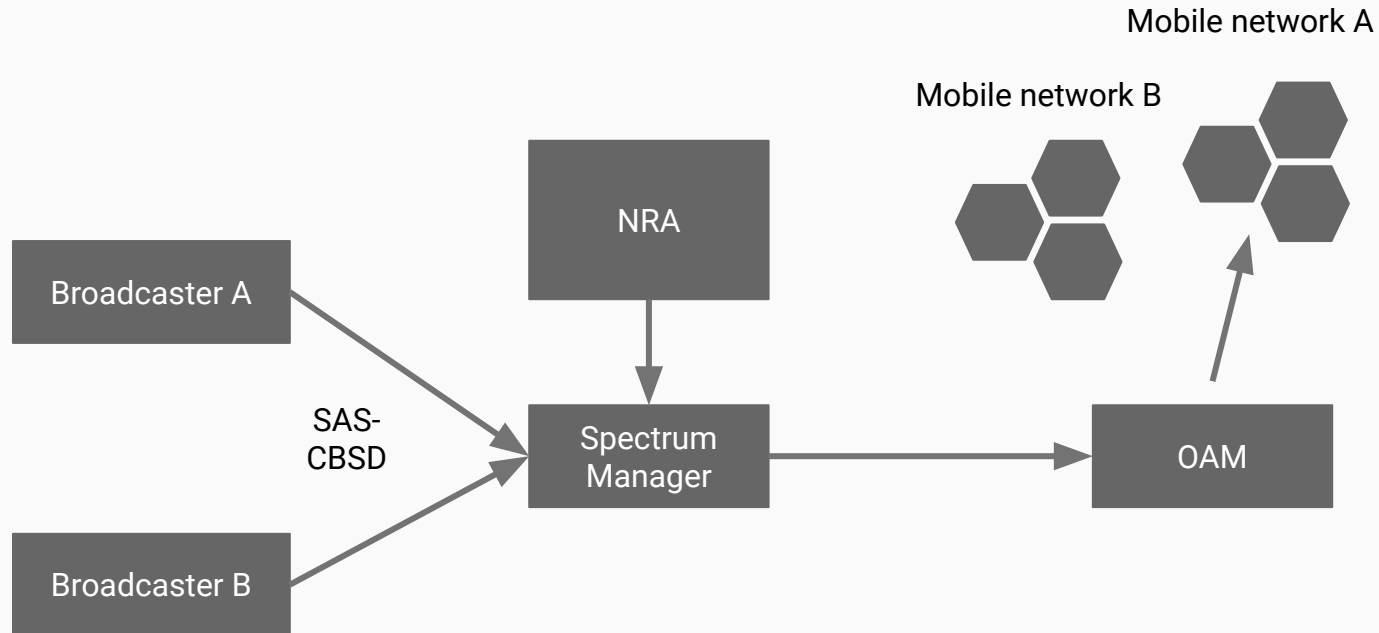
LSA Italy Architecture



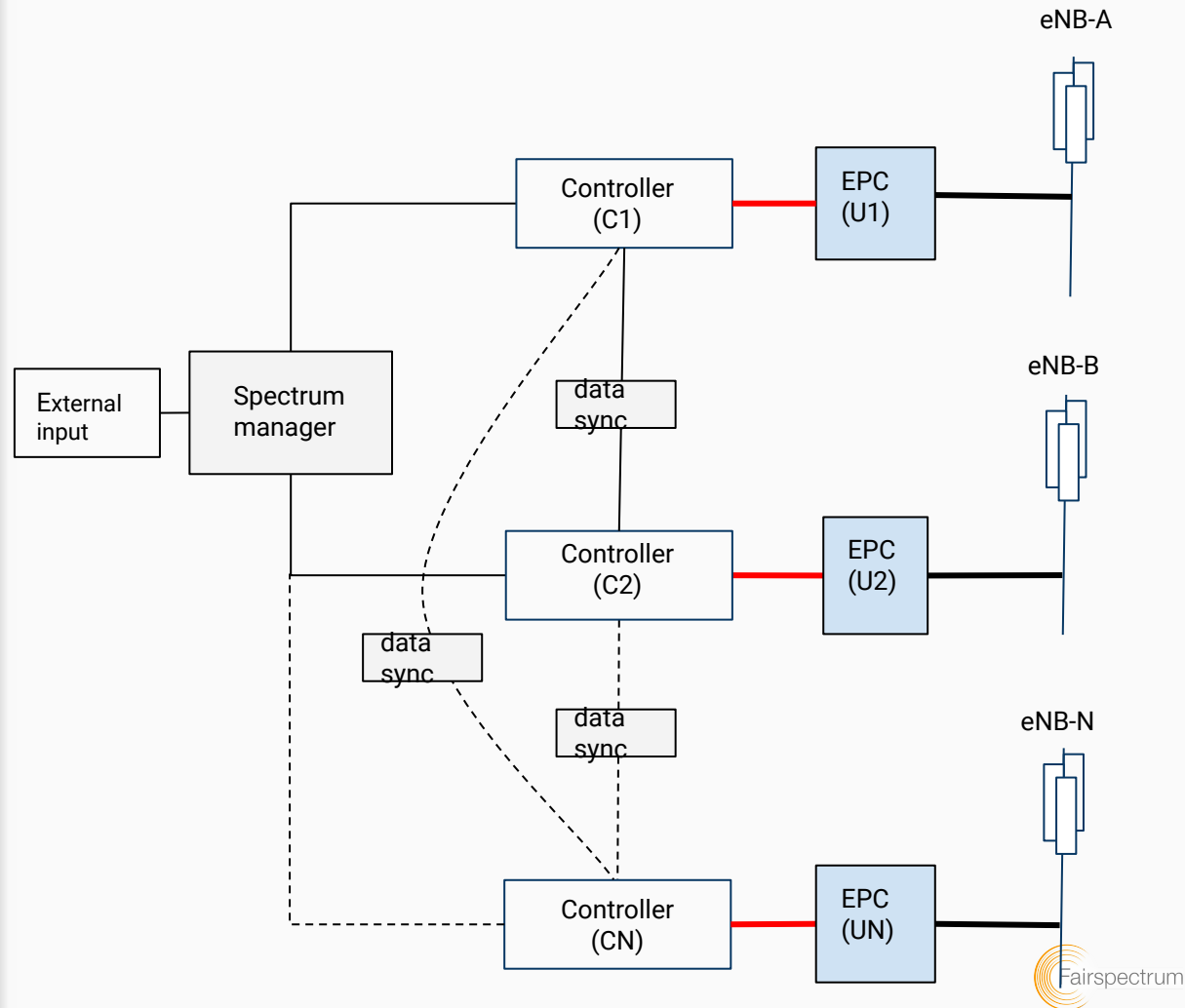
LSA Poland Architecture



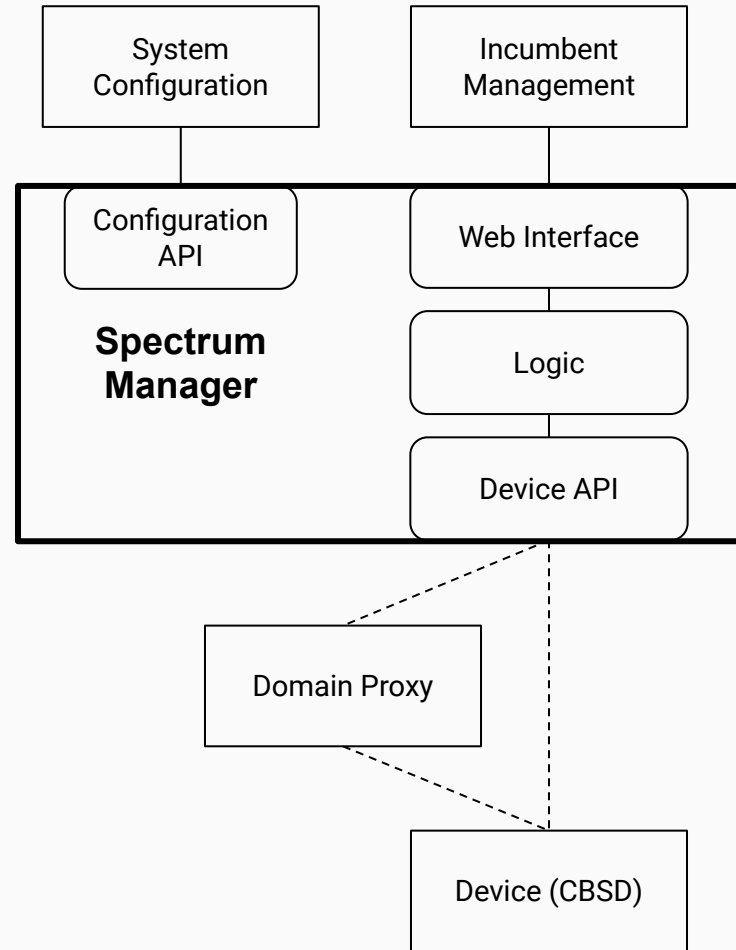
LSA Portugal Architecture



LSA Greece System Architecture



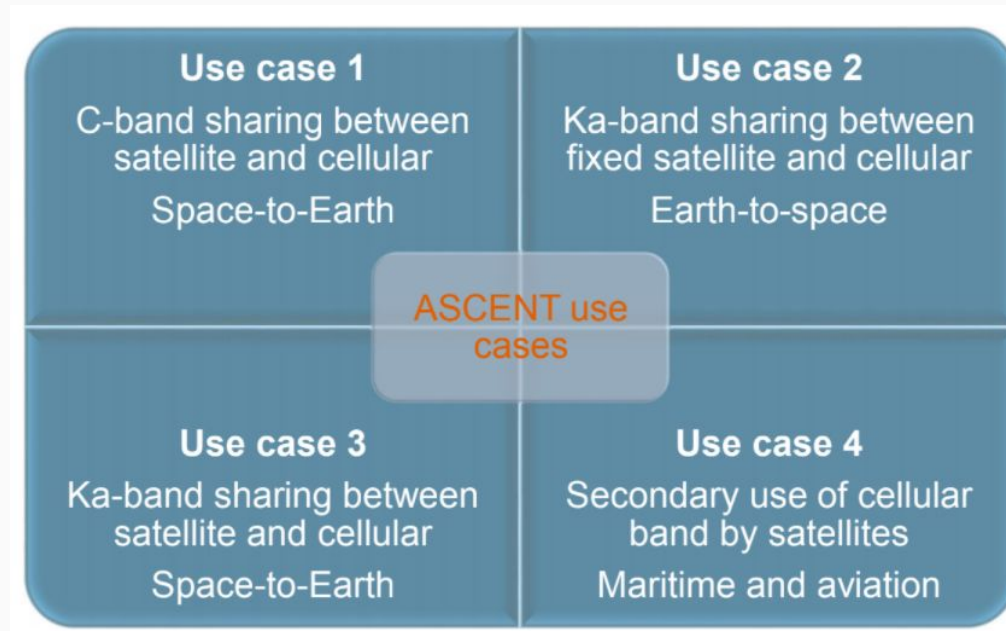
CBRS UK System Architecture



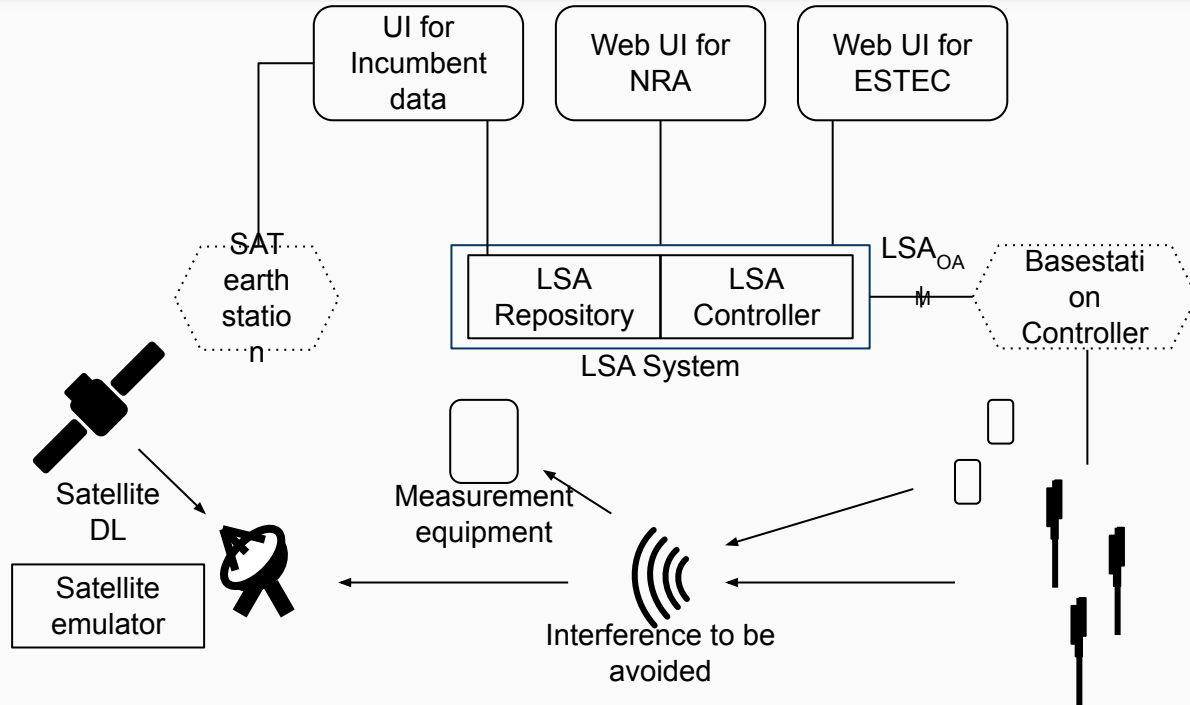


Spectrum sharing between terrestrial and non-terrestrial

Ascent project (Airbus, Fairspectrum, VTT)

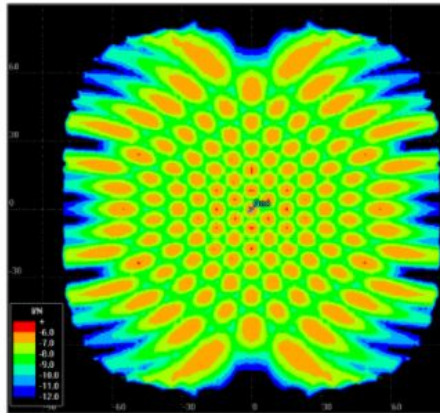


Finland and France Ascent architecture

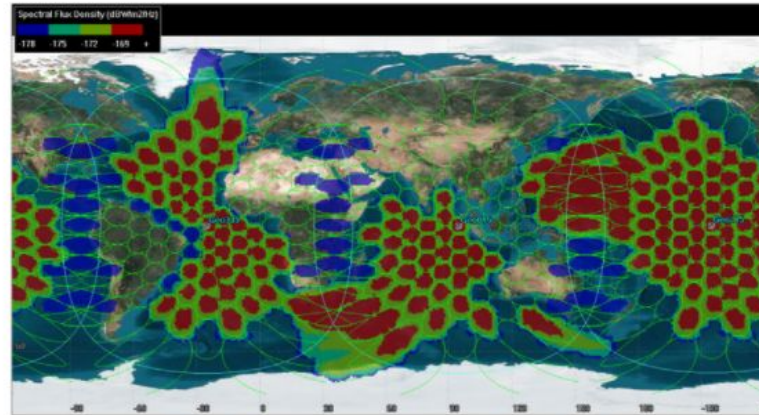


Simulation example

- $//N$ criteria is met with uniform power allocation
- Additional power can be allocated used in areas not covered by cellular systems



$//N$ (same direction – linear polarization)



Optimization of spectral power flux density
(same direction – linear polarization)

