



Consejo Nacional de  
Ciencia y Tecnología



POLITÉCNICA



Grupo de Tecnologías de la Información y las Comunicaciones

# Techno-economic assessment of providing universal service with LTE

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## Content

1. Europe2020 commitments
2. Universal Service definition of broadband access in Spain
3. Network infrastructures in Spain: are enough to reach the Europe 2020 commitments?
4. Technical model
5. Conclusions



## Flagship Initiative: "A Digital Agenda for Europe"

- The aim is to deliver sustainable economic and social benefits from a Digital Single Market based on fast and ultra fast internet and interoperable applications, with broadband access for all by 2013, access for all to much higher internet speeds (30 Mbps or above) by 2020, and 50% or more of European households subscribing to internet connections above 100 Mbps.

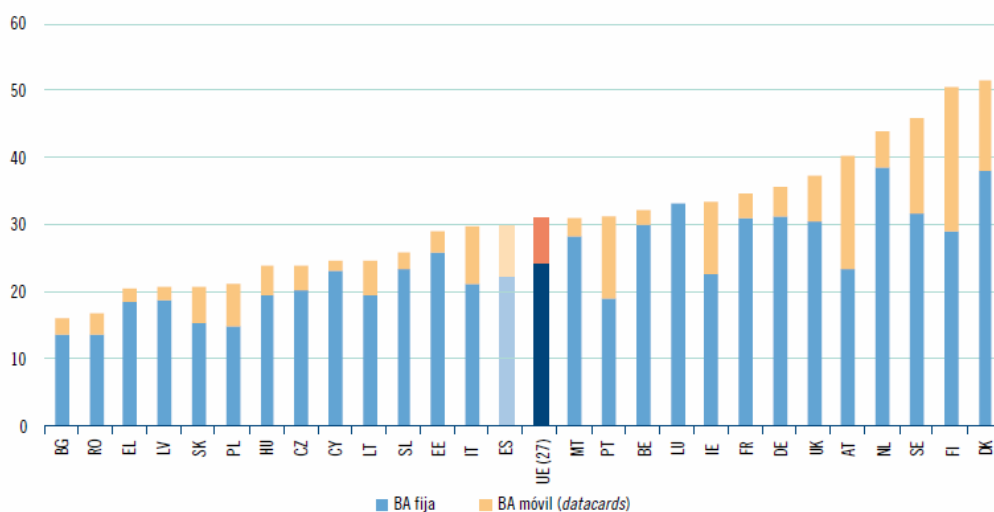
### Questions:

- How much does Universal Service provided by LTE cost?
- It is feasible?



## Fixed and mobile broadband lines in Europe

### PENETRACIÓN DE LA BANDA ANCHA POR REDES FIJAS Y DE *DATA CARDS* (REDES MÓVILES) EN LA UE(27), JULIO 2010 (líneas/100 habitantes)



Fuente: CoCOM, Comisión Europea



# Universal Service definition in Spain 1/2

- **Broadband was not included in the Universal Service legislation (Ley 32/2003 art. 22) until 2011**
- The proposal was included in the Sustainable Economy Law 2/2011, (Ley de economía sostenible -Ley 2/2011, del 4 de Marzo art 52)
- **Article 22 of General Telecommunications Law 32/2003, of November 3rd, establishes the concept and scope of application of universal service, which is understood as a set of defined services which must be available to all end users regardless of geographic location, with a defined quality and at an affordable price**
- **US can be provided by different operators, different infrastructures**
- In the royal Decree 726/2011 it is established that connection to the public electronic communications network with capacity for functional access to the Internet, guaranteed by the telecommunications universal service, must allow broadband data communications at downlink mean throughput of **1Mbps in 24 hrs (fixed access)**



# Universal Service definition in Spain 2/2

- **In the recent Spanish spectrum auction, operators that have acquired spectrum in the 800 MHz band, have committed to deploy ultrafast broadband services, over 30 Mbps, in communities of 5000 inhabitants or less, in order to reach a 98% coverage of the Spanish territory, before January 2020.**
- Recently, on September 17, 2011, the conditions about how will be defined the operator who will be designated to provide, universal service, had been published (order ITC/2464/2011)
- The operators must specify:
  - Subscription Tariff
  - Monthly tariff
  - Price per minute and call establishment
- In the current universal Service, the monthly Tariff are 14€

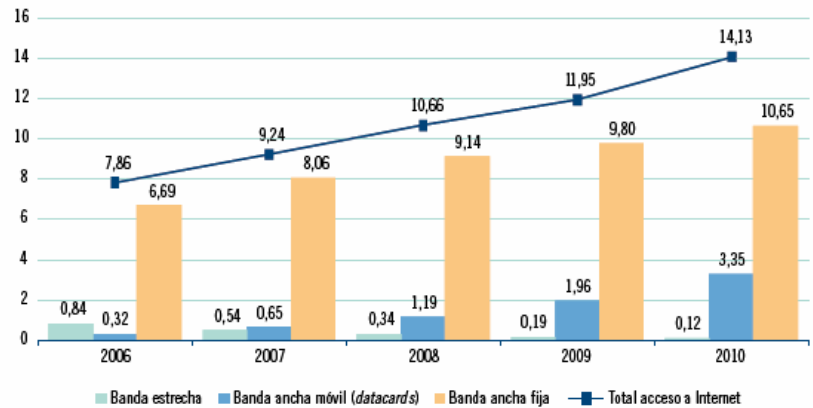
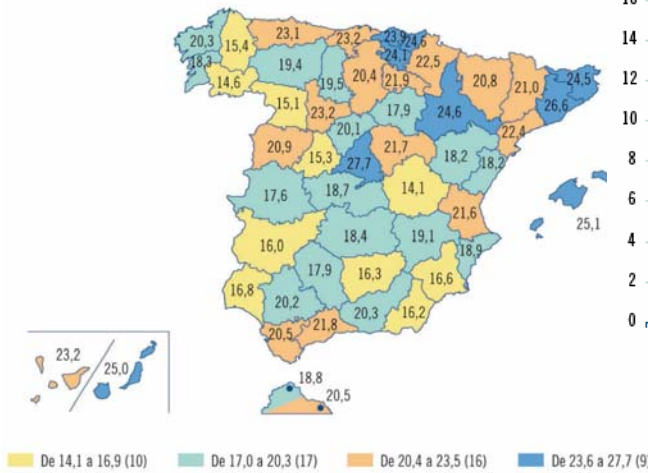
- Retail voice traffic is no under any price control.
- Retail access monthly price is regulated by CMT under supervision of the Dellegated Comission on Economics Affairs of the Government CDGAE.



# Network infrastructures in Spain: are enough to reach the Europe 2020 commitments?

Broadband penetration (lines per 100 inhabitants)

Broadband lines' Evolution (millions)



Source: CMT 2010

## Current broadband penetration in Spain



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## Non-economic areas in Spain and the cost of US related with voice services provision

### Non economic areas

### 1.- Zonas no rentables

Evolución anual de los datos de las zonas no rentables (ZNR):

Deficit non economic areas  
Number of lines  
Number of areas

	2006	2007	2008
Déficit ZNR (en M€)	-76,70	-60,91	-58,38
Número de líneas	669.075	396.086	227.670
Número de zonas	71	57	53

Comunidad Autónoma	Déficit (€)	Nº líneas	Nº de Zonas
Andalucía	-10.959.694	27.678	8
Aragón	-1.125.284	3.756	3
Asturias	-4.147.201	13.122	1
Baleares	-1.729.681	4.623	1
Canarias	-2.926.814	4.746	2
Cantabria	-675.766	1.900	1
Castilla y León	-3.976.005	16.654	9
Castilla-La Mancha	-3.565.453	8.699	5
Cataluña	-3.783.827	36.876	6
Ceuta	0	0	
Comunidad Valenciana	-6.742.257	13.653	3
Extremadura	-1.091.023	3.242	2
Galicia	-11.743.255	49.265	4
La Rioja	-93.685	208	1
Madrid	-1.071.027	2.469	1
Melilla	0	0	
Murcia	-2.247.313	5.894	1
Navarra	-270.322	928	1
País Vasco	-2.230.120	33.957	4
<b>Total general</b>	<b>-58.378.727</b>	<b>227.670</b>	<b>53</b>



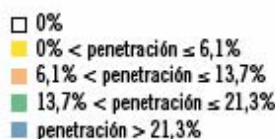
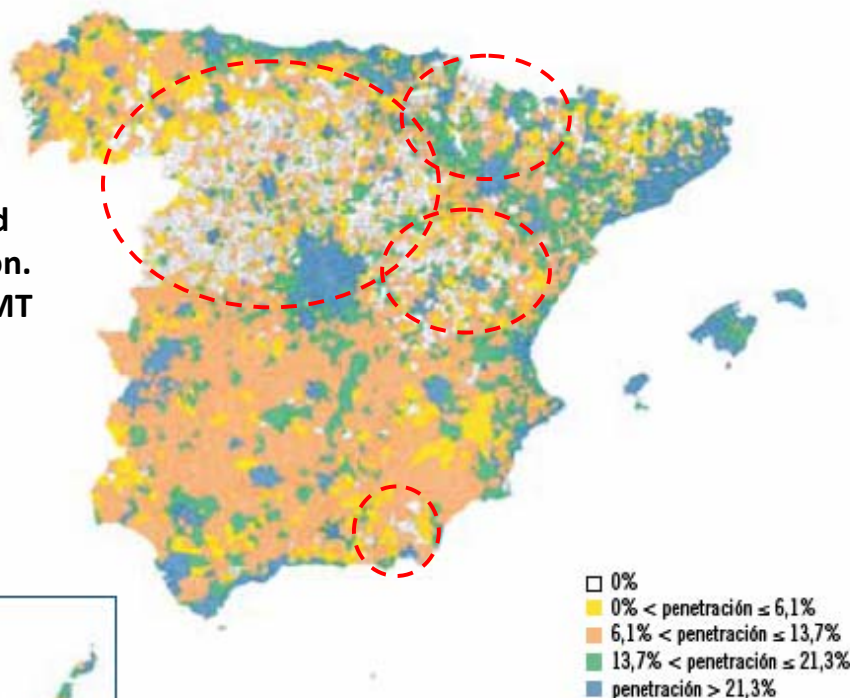
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# Universal Service clasification

Broadband penetration.  
Source: CMT



- Highly concentrated in Castilla-Leon, Navarra and Aragon.
- Those areas should be the target of our study.

### 3 Scenarios

- $IRR < 0$  (no operators want to deploy)
- $WACC > IRR$  (Deploy is very risky)
- $IRR > WACC$  (operator will have low incomes)



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## Techno-economic model

- Based in Ofcom Model published on “Consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues” and “Application of Spectrum liberalisation and trading to the mobile sector. A further consultation” (Ofcom 2010 and 2009)
- Calculate de number of base transceiver station (BTS)

Geotypes	Area (km <sup>2</sup> )	User density (users/km <sup>2</sup> )
Dense Urban	652	23000
Urban	1500	10000
Suburban	16484	910
Rural	36320	413
Open	357143	42

$$Thr = \begin{cases} 0, & \text{for } SINR < SINR_{min} \\ \alpha \cdot S(SINR), & \text{for } SINR_{min} < SINR < SINR_{max} \\ Thr_{max}, & \text{for } SINR > SINR_{max} \end{cases}$$

Where  $S(SINR)$  is the Shannon bound (in bps/Hz) is given by:

$$S(SINR) = \log_2(1 + SINR)$$

And where:

- $\alpha$  Attenuation factor, representing implementation losses
- $SINR_{min}$  Minimum SINR of the codeset, dB
- $Thr_{max}$  Maximum throughput of the codeset, bps/Hz
- $SINR_{max}$  SINR at which max throughput is reached, dB

Desired cell edge throughput	Downlink	Uplink	Mbps
	1	0,144	

K factor	2,000
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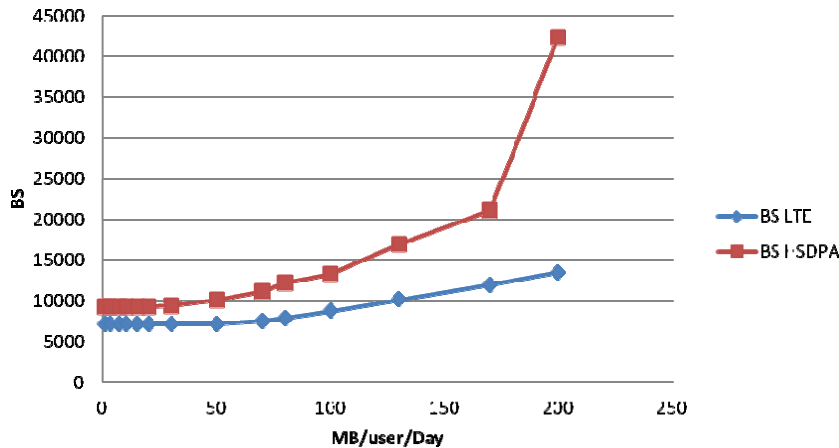
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# Bs needed to provide 1Mbps Universal Service

BS Station LTE Vs. HSDPA



MB/user/Day	0,1	0,3	0,7	1	3	7	10	15	20	25	30	40	50	100
BS LTE	7215	7215	7215	7215	7215	7215	7215	7215	7215	7215	7215	7215	7215	7801
BS HSDPA	9275	9275	9275	9275	9275	9275	9375	10081	11139	12196	13254	16925	21157	42313

Savings between 22% and 34%



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# BS required LTE Vs. HSDPA 1 Mbps throughput

LTE Number of sites

Geotypes	0,1	0,3	0,7	1	3	7	10	15	20	25	30	40	50	100
Dense Urban	707,47	707,47	707,47	707,47	707,47	707,47	707,47	707,47	707,47	707,47	707,47	707,47	707,47	707,47
Urban	1041,30	1041,30	1041,30	1041,30	1041,30	1041,30	1041,30	1041,30	1041,30	1041,30	1041,30	1041,30	1041,30	1041,30
Suburban	2430,25	2430,25	2430,25	2430,25	2430,25	2430,25	2430,25	2430,25	2430,25	2430,25	2430,25	2430,25	2430,25	2430,25
Rural	397,27	397,27	397,27	397,27	397,27	397,27	397,27	397,27	397,27	397,27	397,27	397,27	397,27	397,27
Open	2639,05	2639,05	2639,05	2639,05	2639,05	2639,05	2639,05	2639,05	2639,05	2639,05	2639,05	2639,05	2639,05	3224,35
<b>Total</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.801</b>

LTE Final Cell ranges

Geotypes	0,1	0,3	0,7	1	3	7	10	15	20	25	30	40	50	100
Dense Urban	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69
Urban	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86
Suburban	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87
Rural	6,85	6,85	6,85	6,85	6,85	6,85	6,85	6,85	6,85	6,85	6,85	6,85	6,85	6,85
Open	8,33	8,33	8,33	8,33	8,33	8,33	8,33	8,33	8,33	8,33	8,33	8,33	8,33	7,54

HSDPA Number of sites

Geotypes	0,1	0,3	0,7	1	3	7	10	15	20	25	30	40	50	100
Dense urban	958	958	958	958	958	958	1.058	1.586	2.115	2.644	3.173	4.231	5.288	10.576
Urban	1.410	1.410	1.410	1.410	1.410	1.410	1.410	1.587	2.116	2.645	3.174	4.232	5.290	10.579
Suburban	3.200	3.200	3.200	3.200	3.200	3.200	3.200	3.200	3.200	3.200	3.200	4.232	5.290	10.580
Rural	3.707	3.707	3.707	3.707	3.707	3.707	3.707	3.707	3.707	3.707	3.707	4.231	5.289	10.578
<b>Total</b>	<b>9.275</b>	<b>9.275</b>	<b>9.275</b>	<b>9.275</b>	<b>9.275</b>	<b>9.275</b>	<b>9.375</b>	<b>10.081</b>	<b>11.139</b>	<b>12.196</b>	<b>13.254</b>	<b>16.925</b>	<b>21.157</b>	<b>42.313</b>

HSDPA Final Cell ranges

Geotypes	0,1	0,3	0,7	1	3	7	10	15	20	25	30	40	50	100
Dense urban	0,59	0,59	0,59	0,59	0,59	0,59	0,56	0,46	0,40	0,36	0,32	0,28	0,25	0,18
Urban	0,74	0,74	0,74	0,74	0,74	0,74	0,74	0,70	0,60	0,54	0,49	0,43	0,38	0,27
Suburban	1,63	1,63	1,63	1,63	1,63	1,63	1,63	1,63	1,63	1,63	1,63	1,41	1,26	0,89
Rural	7,38	7,38	7,38	7,38	7,38	7,38	7,38	7,38	7,38	7,38	7,38	6,91	6,18	4,37

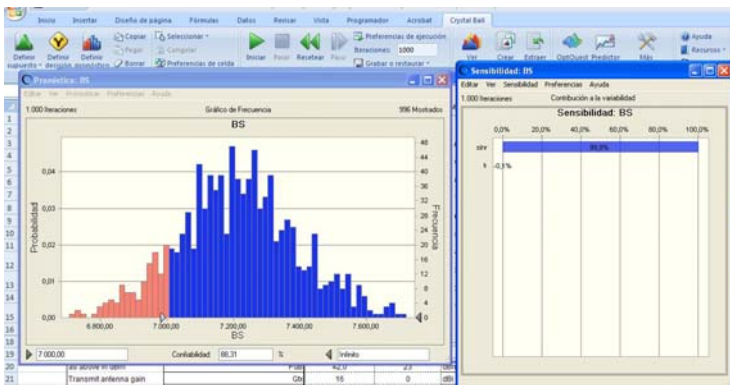


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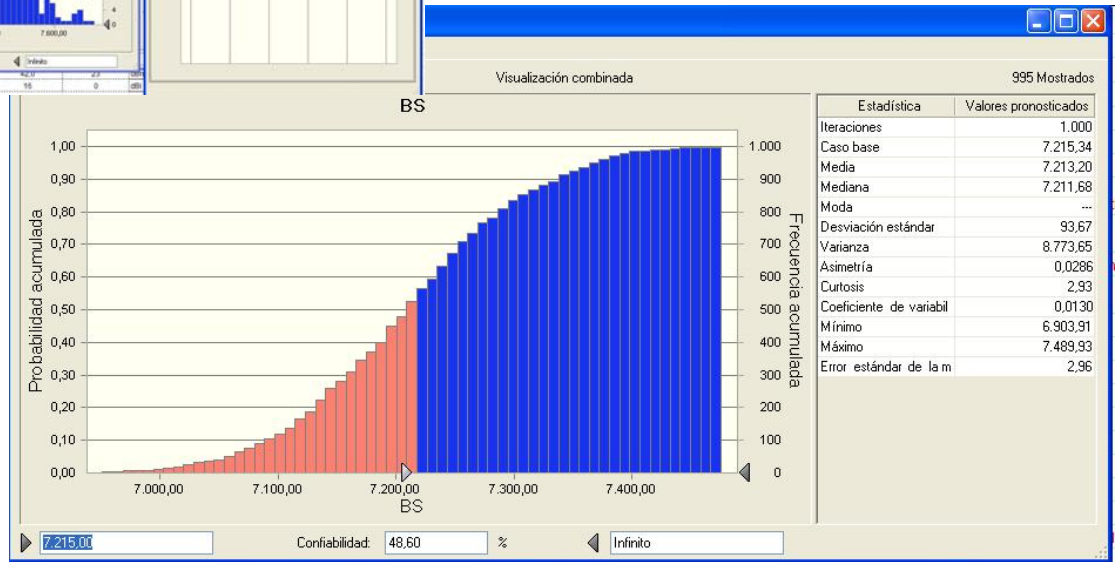
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# Sensitivity analysis



- Crystal Ball software was used
- K factor is irrelevant
- SINR was modeled by a normal distribution (10 % variation)



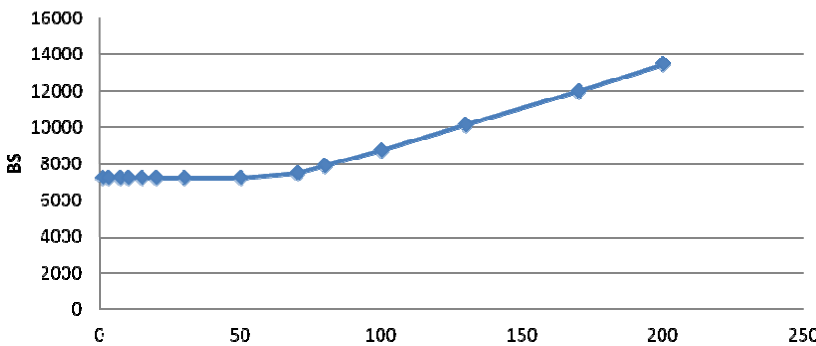
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# BS required LTE 30 Mbps throughput

BS Station LTE Vs. HSDPA



HSDPA is not capable to reach that data rate

Number of sites LTE 30

Geotypes	1	3	7	10	15	20	30	50	70	80	100	130	170	200
Dense Urban	707	707	707	707	707	707	707	707	707	707	707	707	707	831
Urban	1.041	1.041	1.041	1.041	1.041	1.041	1.041	1.041	1.041	1.041	1.041	1.041	1.041	1.041
Suburban	2.430	2.430	2.430	2.430	2.430	2.430	2.430	2.430	2.430	2.430	2.430	2.430	2.430	2.430
Rural	397	397	397	397	397	397	397	397	397	397	416	540	707	831
Open	2.639	2.639	2.639	2.639	2.639	2.639	2.639	2.639	2.910	3.326	4.157	5.404	7.067	8.314
<b>Total</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.215</b>	<b>7.486</b>	<b>7.902</b>	<b>8.752</b>	<b>10.123</b>	<b>11.953</b>	<b>13.448</b>

Final Cell Range

	1	3	7	10	15	20	30	50	70	80	100	130	170	200
Dense Urban	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,63
Urban	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86	0,86
Suburban	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87	1,87
Rural	6,85	6,85	6,85	6,85	6,85	6,85	6,85	6,85	6,85	6,85	6,69	5,87	5,13	4,73
Open	8,33	8,33	8,33	8,33	8,33	8,33	8,33	8,33	7,93	7,42	6,64	5,82	5,09	4,69



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- For the 2013 Europe 2020 commitment, Spain is capable to reach 1Mbps Universal Service obligation with HSPA network
- For the 2020 commitment, the deployment of NGN, must be needed to reach 30 the Mbps goal
- LTE network will be a good alternative to reach the objective due to its high bit rate, and the operators' commitment to deploy ultrafast broadband services, over 30 Mbps, in communities of 5000 inhabitants or less
- There are other infrastructures that are also capable of reaching 30 Mbps, such as VDSL, HFC, Optical Fibre, satellite, etc.

## Thank you

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