LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Fakultät für Betriebswirtschaft
Munich School of Management

Broadband – Status, Plans and future Outlook

(selected results from current projects)

Münchner Kreis - Strategie Workshop

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Agenda

Introduction

Broadband and the Digital Divide

Digital Dividend no substitute for wireline, but necessary complementary solution

Solution PPP?

Broadband Plans have been published with clear targets by various governments; funding is massive, but search for the right path is still ongoing.

Hot Topics

Current Situation

- Broadband hardly available in rural areas
- High competition levels in cities with multiple access technologies
- Massive infrastructure investment programs, e.g.
  - USA: 7.2 billion US$ (~ 17 EUR/head)
  - EU: 1 billion EUR (~ 2 Eur/head)
  - Australia: 43 billion AU$ (~ 1.100 EUR/head)

- Currently 56 kBit/s defined as Universal Service according to European Framework
- Different technologies under survey
- Digital Divide widening
- Broadband acknowledged as important, but path to complete broadband coverage not existent

Additional Challenges

Deploying nationwide Broadband

1. Is public engagement required for rural broadband at all?
2. What sort of engagement is most effective?
3. What kind of infrastructure does guarantee highest sustainability?

Agenda

- Introduction
- **Broadband and the Digital Divide**
- Digital Dividend no substitute for wireline, but necessary complementary solution
- Solution PPP?

The current broadband definition has always been behind actual bandwidth demand, driven by supply and not demand.

Broadband Characteristics

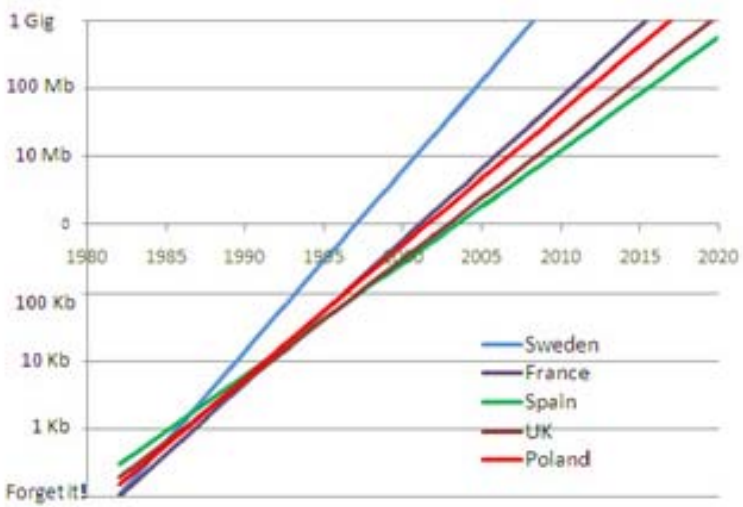
Defining Broadband

- Every Internet connection with a significantly higher performance than 56 kBit/s PSTN (old)
- ITU: 1.5 – 2.0 Mbit/s transmission capacity
- OECD: 256 kBit/s download capacity
- FCC (update):
  - First Generation Data: 200 – 768 kBit/s
  - Basic Broadband: 768 kBit/s – 1.5 Mbit/s
- Germany: 1.0 MBit/s in Broadband Strategy
- BMWi: 128 kBit/s
- Switzerland: 600 kBit/s Universal Service
- Australian Broadband Guarantee: 512/128 kBit/s

- Bandwidth Supply drives Demand
- New Technologies not imaginable yet

How much Bandwidth is enough?

- Bandwidth Demand 1980 – 2020:



- Nielsen‘s Law
  - Supply drives demand; model derived from Gilder‘s Law
  - Bandwidth doubles every 21 months; e.g. UK matches assumption for the last ten years

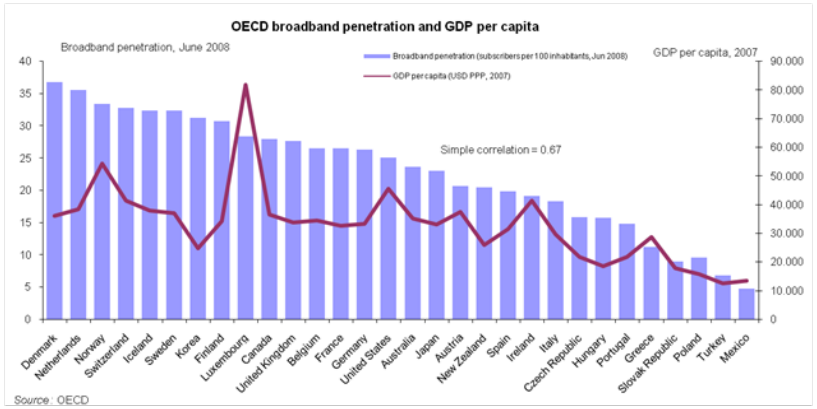
Source: Nielsen (1998); ITU (2003); Tanenbaum (2003); OECD (2009); BMWi (2009); Bogaert (2008)

Besides an accepted positive economic impact of broadband, no connection means not only being offline, it ends with being excluded from the society.

Relevance of Broadband

Driver for Economy and Society

I Economic Impact

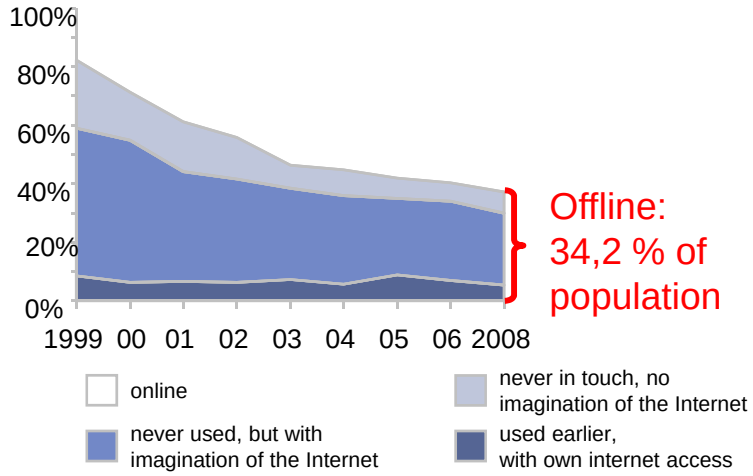


- Correlation BB penetration and GDP ~ 0.67
- "General Purpose Technology" acc. to OECD

II Social Impact

- Electronic communication as common form of social interaction (mail/messaging/portals/…)
- Information (transactions/travel/entertainment…)

Digital Divide in Germany



- Digital Divide: Exclusion from Information Society
- 34 % are without access
- 22 % do not know the Internet at all

Interrelationship?
28 % live in rural areas

Source: OECD (2008); Gerhards/Mende (2008)

The absence of a consistent definition and lacking of public willingness to invest keeps rural areas currently offline.

Lacking Availability of Broadband 1/2

Broadband Definition

- ITU: ~ 1.5 – 2.0 Mbit/s
- OECD: > 256 kBit/s down
- FCC: 768k – 1.5 MBit/s

Universal Service

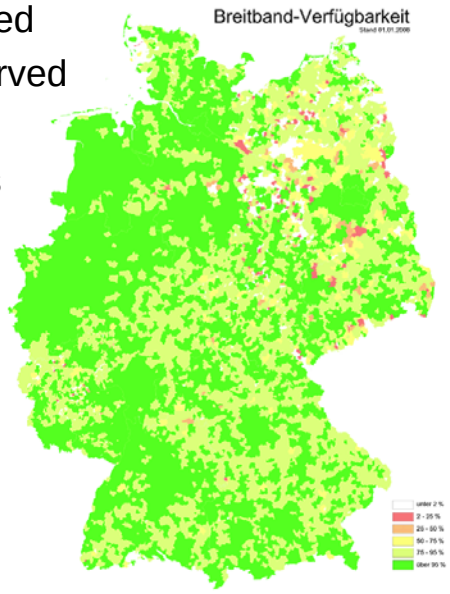
- European Union: 56kBit/s
- United States: telco services
- Switzerland: 600/100 kBit/s

Competition

- Cities/population dense areas
  - Parallel infrastructure
  - FTTH available in competition
- Rural areas
  - Single/no broadband provider

"Breitbandatlas" in Germany

- *Breitbandatlas* lists >1 mio people offline:
  - 713 municipalities not served
  - 632 municipalities underserved
- Broadband: ~ 128 kBit/s
- Increasing to 1 MBit/s reduces availability by another 8 % on national level
- „The German market is remarkable with a national DSL penetration rate of 17.3% but only 5.9% in rural areas."[1)]
- German Broadband Strategy:
  - 2010: 1 MBit/s area wide
  - 2014: 75 % of HH with +50 Mbit/s



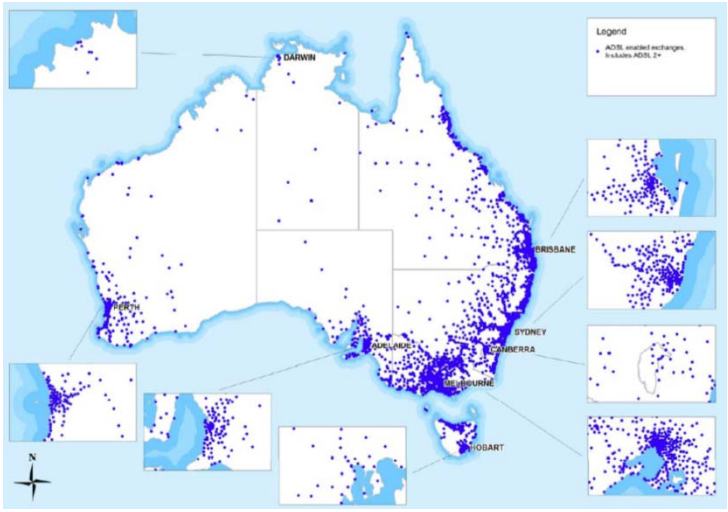
Public support of announced 150 mio. EUR will not suffice at all in order to fulfill these targets

Source: [1)] per household, Idate (2007); BMWi (2008); BMWi (2009a)

In Australia, just 2.6 % of the entire population live in remote areas, but only 48% are within range for an broadband access with more than 1.5 MBit/s.

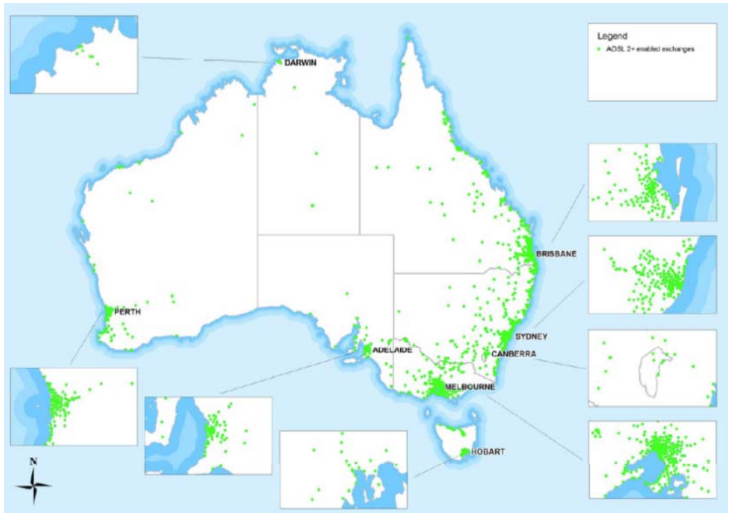
Lacking Availability of Broadband 2/2

ADSL Penetration Australia



- 2008: >45 % of exchanges without DSLAM
- Wireless only available in residential areas

ADSL2+ Penetration Australia



- 2008: only 48 % of entire population live within 1.5 km range of ADSL2+ enabled exchanges

Australian Government took immediate action in 2009 with National Broadband Network:

- Investment of AUD 43 billion over eight years, starting with 4.7 billion in the network
- Australian Broadband Guarantee for all Australian residents for metro-comparable services

Source: ACMA (2008); Australian Bureau of Statistics (2004); DBCDE (2009);

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The term "Digital Dividend" was born by combining the potential benefits from an alternative use of frequencies formerly assigned to terrestrial TV.

Switchover from analog to digital terrestrial television broadcasting

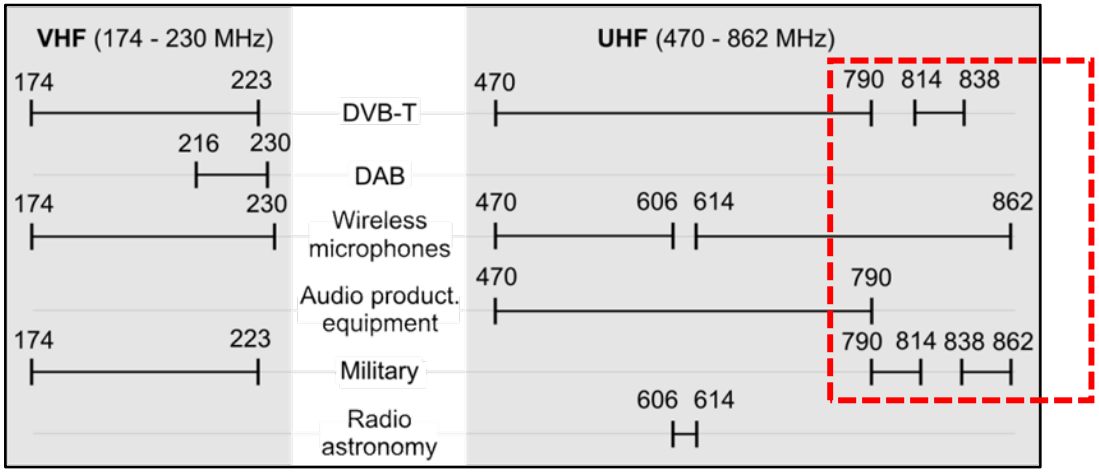
Digitalization

Switchover from analogue to digital TV

- Digitalization and Compression
- For same amount of programs and coverage, digital standards need a fraction of the spectrum allocated for analog broadcasting

Spectrum has economic value and is regulated, which led to the term

"Digital Dividend"



Digital Dividend in Germany

The actual size of the Digital Dividend depends on national choice;
in Germany 790 – 862 MHz

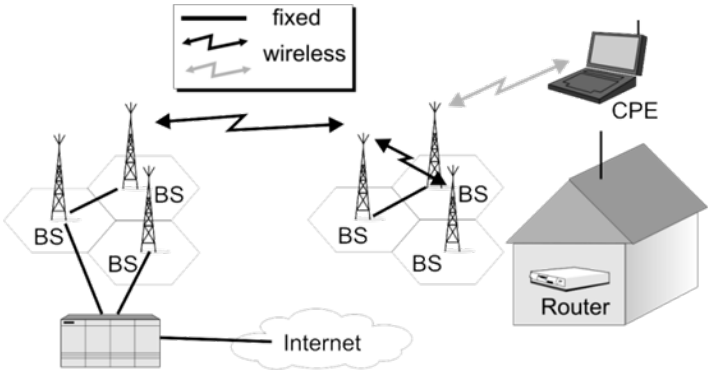
Source: Bundesnetzagentur, Frequenzbereichszuweisungsplan (2008)

Establishing wireless broadband coverage is limited by physical restrictions and a trade off between reach, speed, spectrum available and transmission power.

Approach, Relationships & Limitations

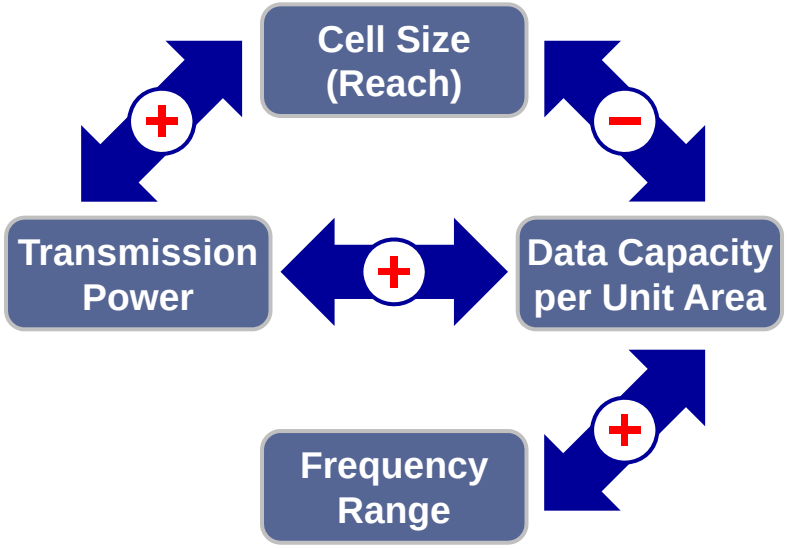
Wireless BB for rural areas without wireline BB

Rural Wireless Broadband



- Aggregation Network of e.g. MNO
- Base stations connected via cable/microwave with backbone
- CPE is connected
  - Directly, e.g. UMTS modem
  - Indirectly via UMTS inhouse router

Trade Off



(+) **Positive Relationship**

(−) **Negative Relationship**

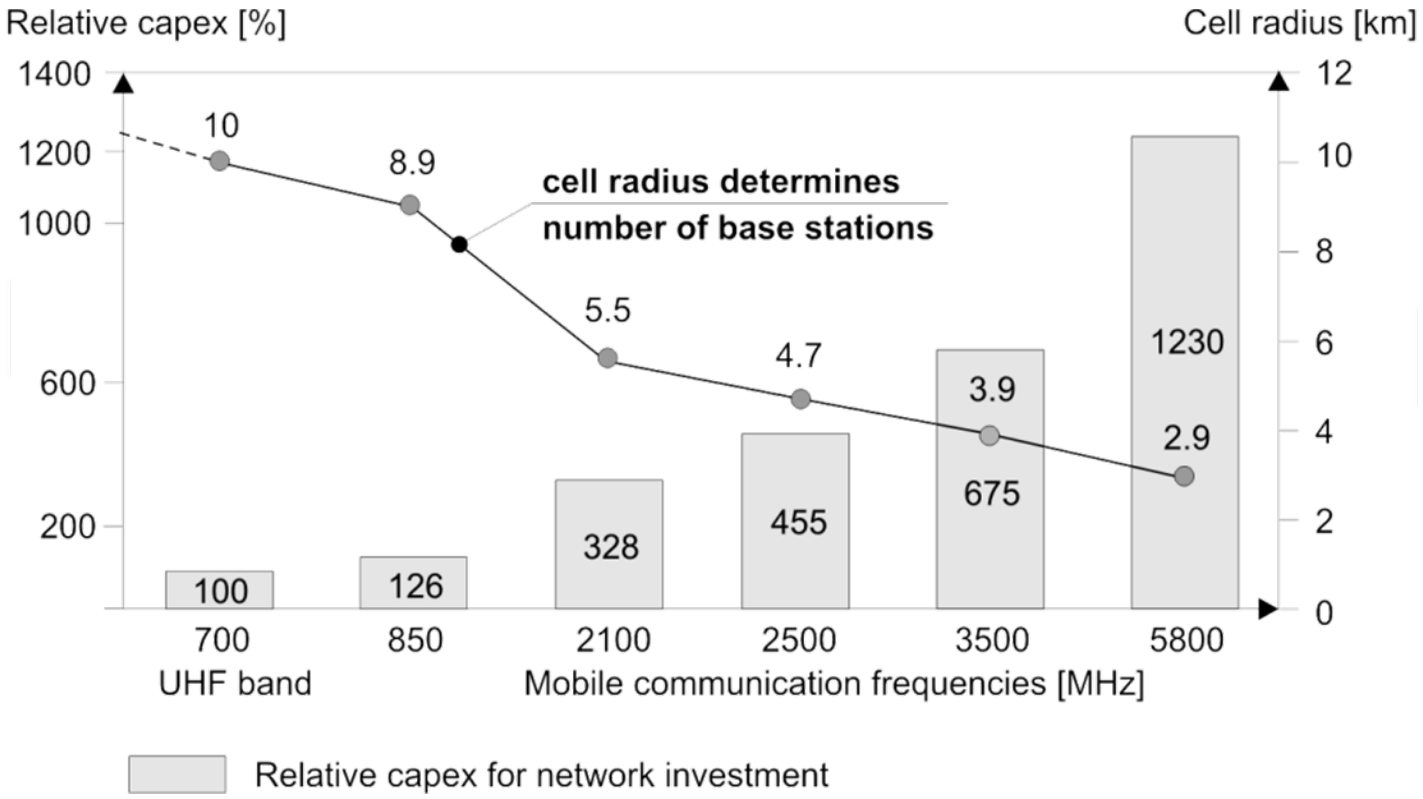
- **CAPEX decrease with lower frequencies, but data throughput accordingly**
- **Wireless technologies are less reliable, and by a multiple slower than fixed**

Source: Picot/Jondral/Elsner/Grove (forthcoming)

Lower operating frequencies allow for larger cell sizes and hence lower CAPEX to achieve coverage.

Constant Data Capacity per Cell

Relationship between Frequency and required # of Base Stations for Coverage

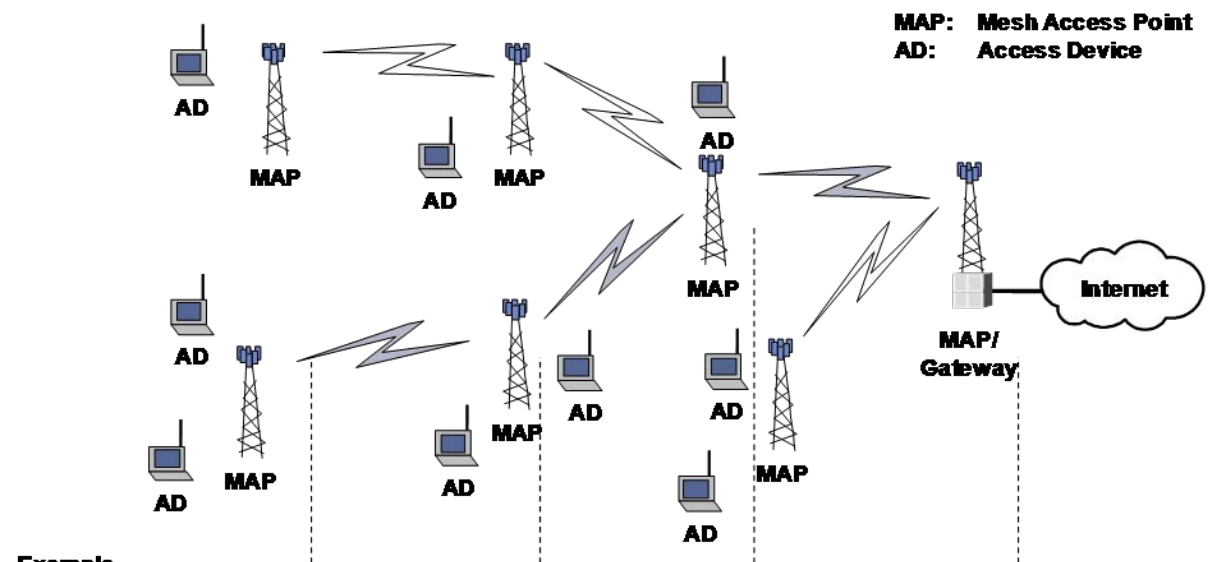


Source: According to Krämer (2009), Forge/Blackman/Bohlin (2007), p. 9.

Wireless today is not sustainable for broadband access in rural areas and should be regarded as complementary solution for mobile devices only.

Wireless for rural Areas

Shared Medium Phenomenon



Example

Maximum Bandwidth	100 MBit/s	100 MBit/s	100 MBit/s	100 MBit/s	Backbone
Avg. shared Bandwidth	... x 1/2 ~ 2.5 MBit/s	1/2 x 1/3 x 1/3 ~ 5 MBit/s	1/2 x 1/3 ~ 16 MBit/s	1/2 ~ 50 MBit/s	

Wireless Broadband

- Shared Medium
  - Usage creates negative externalities to other users
  - Physical limitations in frequency spectrum
- Availability and Reach
  - Tradeoff between cell size and transmission power
- Quality
  - QoS below wireline
- Acceptance
  - Resistance of population due to health concerns

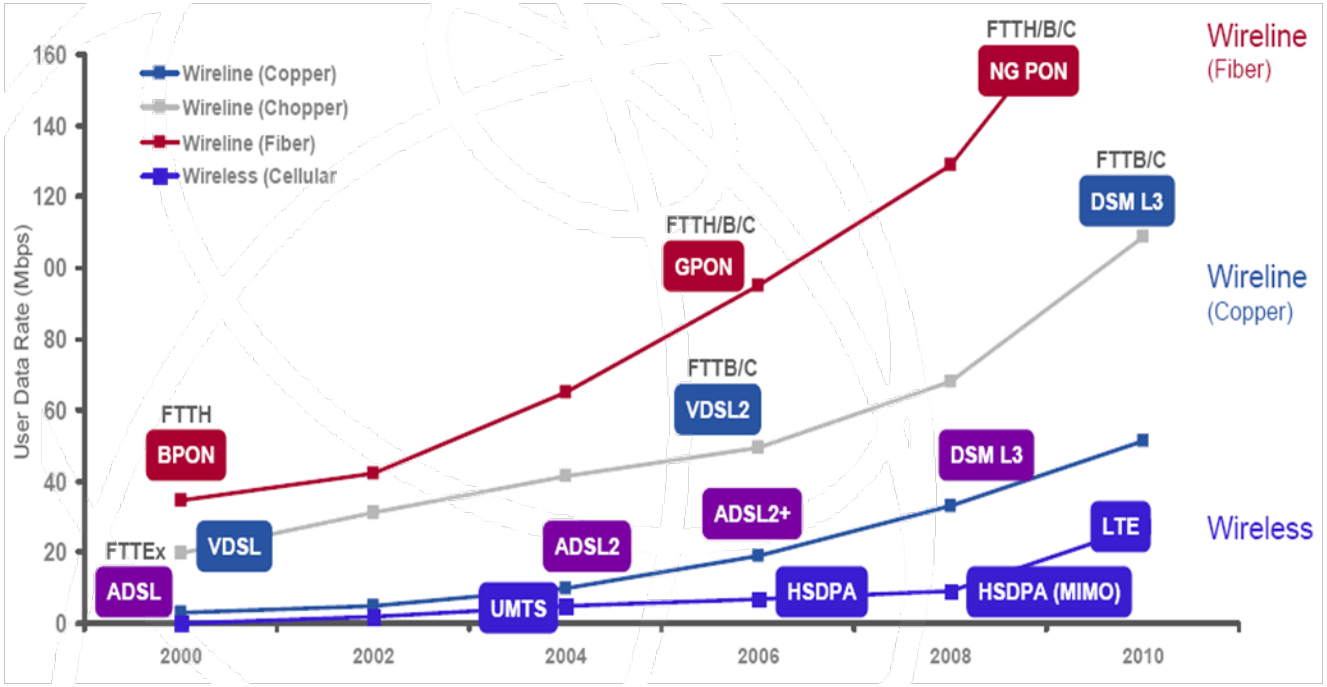
Digital Divide not solved via Digital Dividend

Source: Picot/Jondral/Elsner/Grove (forthcoming); Luo et al. (2008); Börnsen (2008); Vary/Lüders (2008);

Wired communications is ahead of wireless communications by orders of magnitude; costs per transmitted bit are significantly lower.

Capacity Comparison

Growing Gap between Wireless and Wireline Technologies



Shared Medium Wireless

- Usage creates negative externalities to other users
- Physical limitations in frequency spectrum

- **Ultra high data rates only achieved over very short distances wirelessly**
- **Wireless access points should be as close as possible to the CPE**

Source: Based on BMWi (2008), p. 20 and Scheck et al. (2008)

FTTx Technologies are regarded as highly sustainable for deployment of broadband to rural areas.

Sustainability of Technologies

Technology Shortcomings

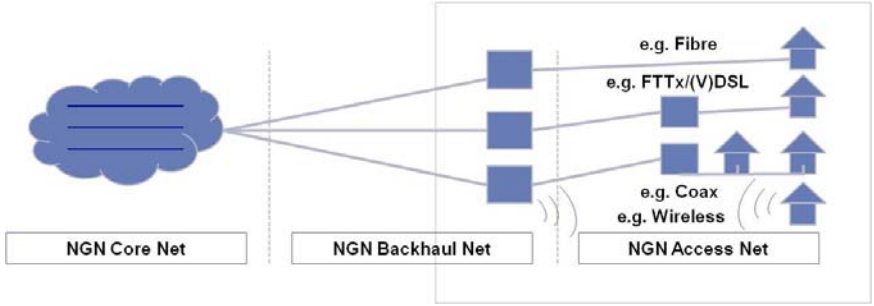
Wireline

- DSL suffers from too long LL in rural areas
- Coax not available in rural areas, and if, not upgraded to backchannel
- Fibre rollout is most expensive deployment, but cost can be reduced by upgrading later, beginning with FTTX alternatives

Wireless

- WLAN not for long range
- WiMax not relevant
- Satellite with latency problems
- UMTS not available in rural areas

Fibre Core Technology Deployment



- Core and backhaul network mandatory fibre
- FTTH preferred, where not applicable, use of existing infrastructure to connect customer
- Include WLL temporary overcoming delays
- Ensure upgradability

- FTTH deployments do not share bandwidth in a sense which imposes negative externalities on single users
- NGN P2P deployment in focus
- Usage of all technologies available to reduce time lags and connect as many people as possible

Source: Picot (2008a); Tanenbaum (2004)

For NGA different subnational regulatory regimes are required to cope with differences in metropolitan and rural areas.

Broadband Coverage

Situation

Metropolitan Broadband Coverage

- Private FTTx deployments in major European cities
- High availability of competitive offerings (e.g. cable, DSL, W…)
- Variety of passive infrastructural components (e.g. ducts,…)
- Sustainable competition level

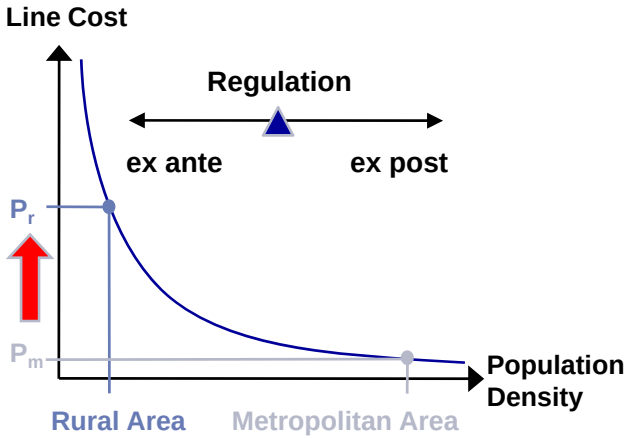
Rural Broadband Coverage

- Limited access
- Often limited to one technology (e.g. DSL) with less capacity
- No existing NGA business plans

Digital Divide[1)]

- Increasing pace to two-tier society: online and offline
- Potential negative welfare effects for entire society

Subnational Markets



- Accept higher price level in rural areas (political issue)
- Ex ante regulation will be required in rural areas

I Define subnational markets, accepting differential pricing

II Promote infra-structure rollout by government with specific means

III Fulfill Lisbon Strategy goals, with EU as knowledge based world leader

- Define subregional and/or subnational markets
- Promote infrastructure rollout with e.g. specialized providers, PPPs, subsidies, regulatory support

Source: Picot 2008; Lisbon Summer Summit Conclusion of March 2000; 1) Unofficial consolidated Version of Framework Directive 2002/21/EC (ITRE Version), Preamble

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- **Solution PPP?**

Hybrid approaches show highest potential in order to deploy broadband access to rural areas with regard to implementation speed and sustainability.

Infrastructure Enforcement Mechanisms

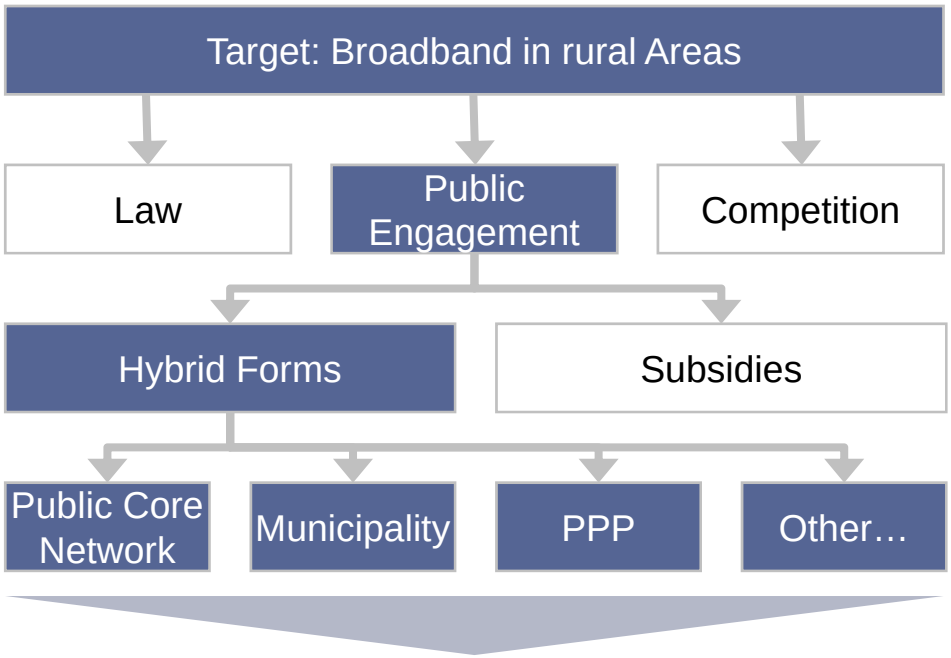
I	**Law/Legal Enforcement** ▪ Universal Service Standard ▪ Universal Service Obligation ▪ Functional Separation	▪ Common European Position? ▪ Duration? ▪ Resistance
II	**Independent** ▪ Business Case driven (Incumbent) ▪ Business Case driven (Competitor)	▪ Business Case not positive ▪ Resistance against sub national markets
III	**Subsidies** ▪ Direct as a fraction/percentage ▪ Indirect via consumer	▪ Market distortions? ▪ Fight for subsidies ▪ Competition Law
IV	**Hybrid** ▪ Public Private Partnership ▪ Publicly owned Networks	▪ Public Private Partnership ▪ Publicly owned core networks ▪ Publicly owned networks/network elements

Source: Laffont/Tirole (2000); Wernick (2007); EC (2007)

Hybrid Forms are suited best for rural areas due to highest implementation speed, availability of financing mechanisms and technological sustainability.

Hybrid Forms for rural Broadband

Implementation Scheme



Audit: Compliance with Common/EU Law, Competition and Antitrust Law

Major Reasons

I Speed of Implementation
- Competition not applicable
- Law/Subsidies correlate with legal intervention

II Financing
- Governmental guidance
- Combined with private business financing model

III Sustainability
- Law/Subsidies technology neutral
- Competition in rural areas will not select sustainable technology

Source: Budäus (2004), Picot/Grove (2009)

Cases under survey proof public engagement as major driver for successfull broadband deployment projects in rural areas.

Results from Case Studies

1 Is public engagement required for rural broadband?
- High demand in rural areas
- Competition will not provide access

2 What sort of engagement is most effective?
- Hybrid forms show highest success rates
- Cases proof applicability and efficiency

3 What kind of infrastructure does guarantee highest sustainability?
- FTTx with NGN core network are sustainable
- Wireless as complementary solution only

Success Factors

- **Public Engagement**
  Governmental aid/subsidy required
- **Common Interest**
  Guidelines for State Aid Law
- **Entrepreneurship**
  Engagement of local activists
- **Local Characteristics**
  Integrate related local needs (communityTV, etc.)
- **Low Entry Barriers**
  Free testing period/opt-out option

Source: Picot/Grove (2009)

Thank you!