Broadband:

Changing the Game

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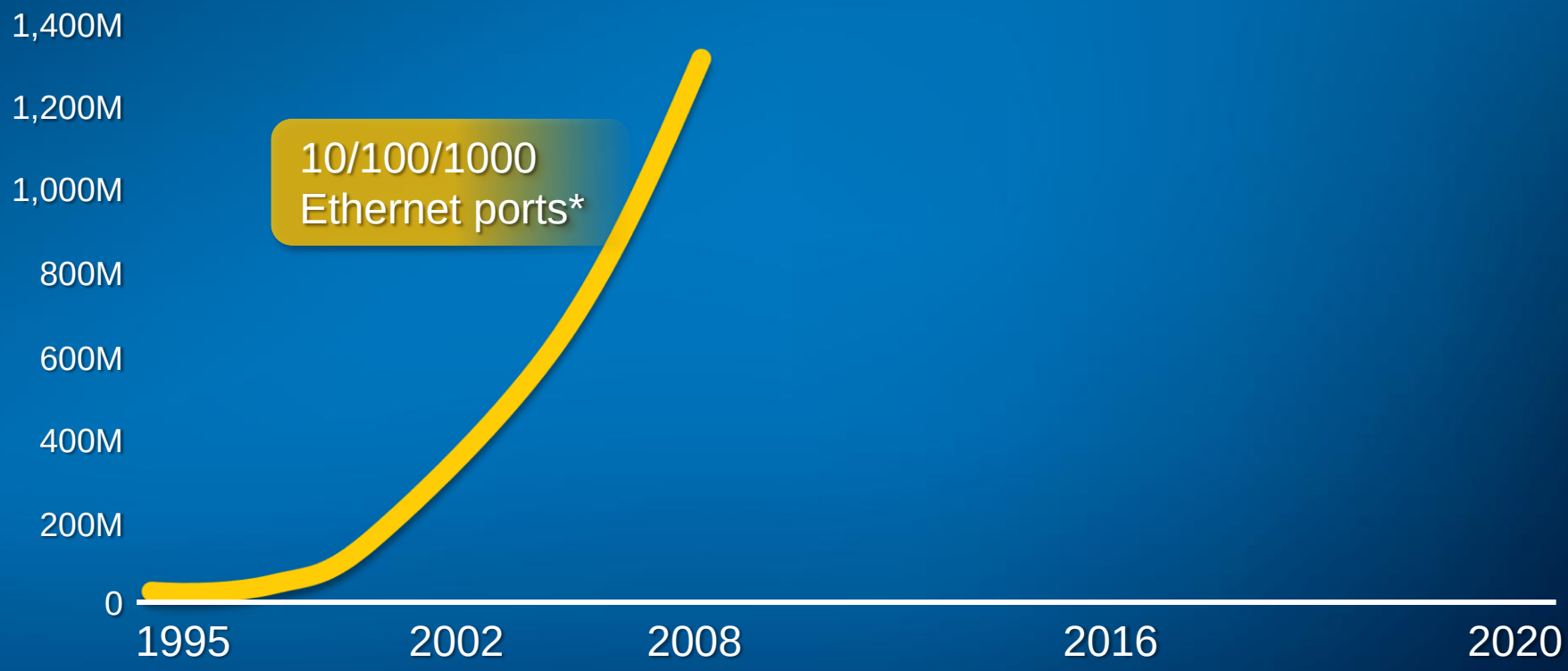
Intel's Vision: Three Waves of Internet Access



- Helped define the standard
- Drove Integration
- Championed Manageability
- Manufacturing in scale
- #1 MSS for Ethernet LAN-on-Motherboard*
- #1 MSS Network Interface Cards*

*Source: Dell'Oro Group, Q1'08; **Source: IDC, Q1'08; Intel estimates; ***Source: Intel Estimates

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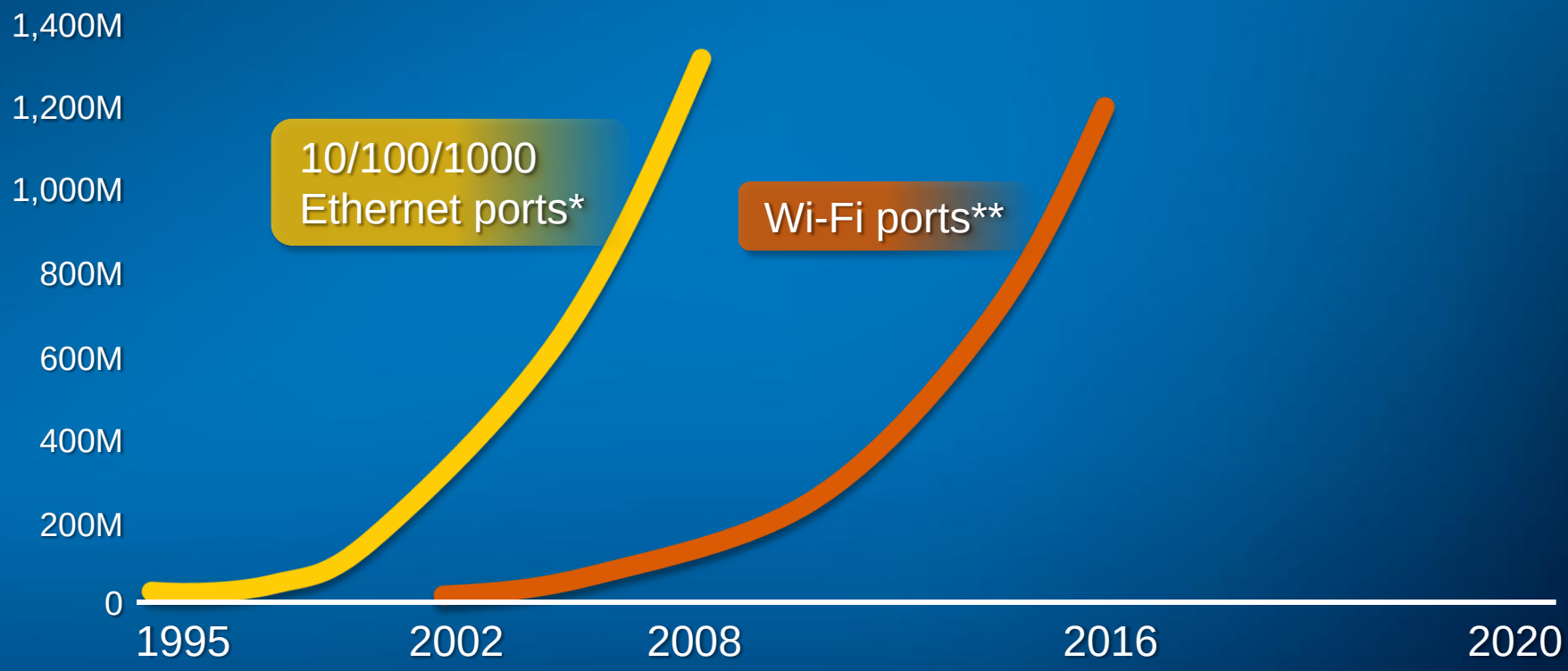

- Intel ® Centrino® technology means wireless
- Drove hot spot footprint
- Championed Security
- Standardization across ecosystems
- Embedded wireless form factors
- Significant Intel Capital investment

*Source: Dell'Oro Group, Q1'08; **Source: IDC, Q1'08; Intel estimates; ***Source: Intel Estimates

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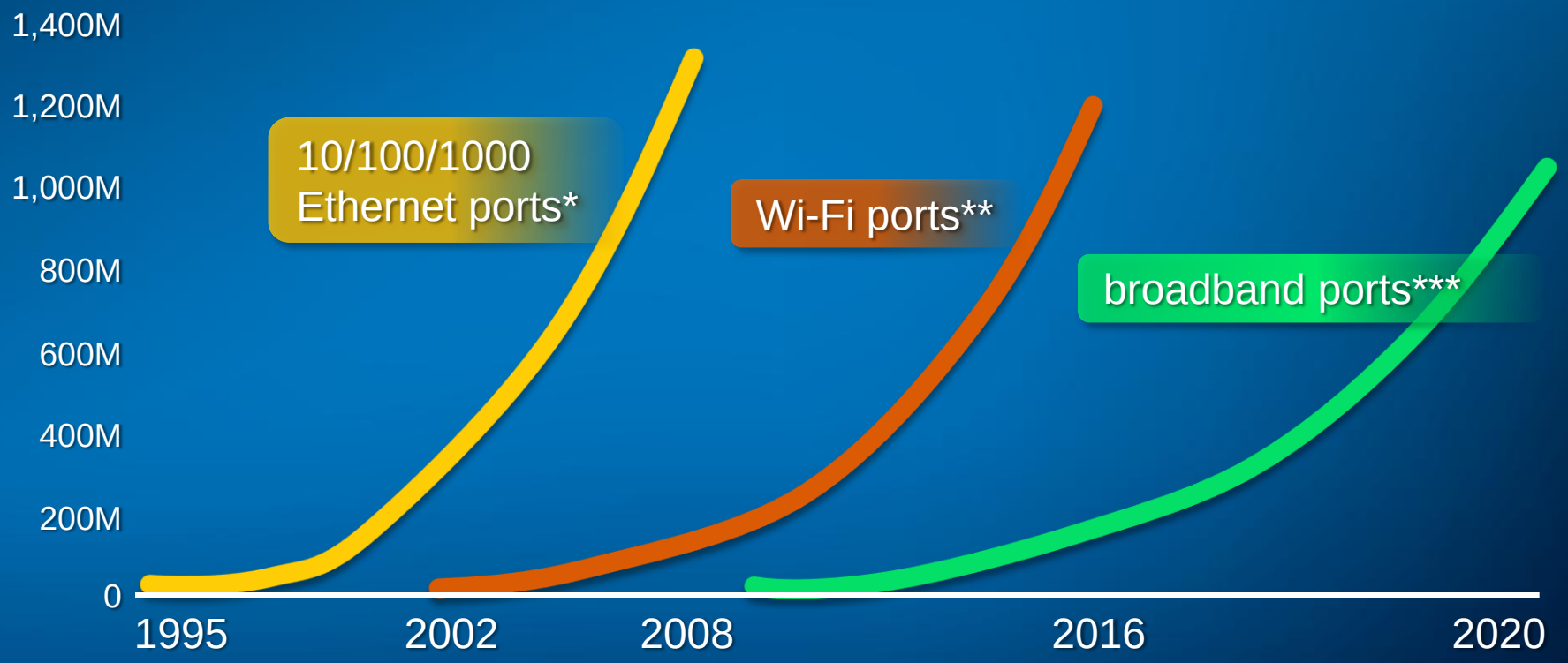


- Defining ITU 4G Standards
- Broadband into notebooks
- Securing Spectrum

- Driving the Roadmap, Silicon
- Open Patent Alliance
- Significant Intel Capital investment

*Source: Dell'Oro Group, Q1'08; **Source: IDC, Q1'08; Intel estimates; ***Source: Intel Estimates

Challenges

Mobile Voice vs. Mobile Internet

Traffic Equivalents*

1 Smartphone = 30 Handsets

1 Laptop = 450 Handsets

~ 10 Kbps Constant Rate

A network optimized for mobile voice cannot handle high numbers of mobile internet users

1-5 Mbps Burst Traffic

More Spectrum Needed

More Backhaul And Different Network Architecture Required

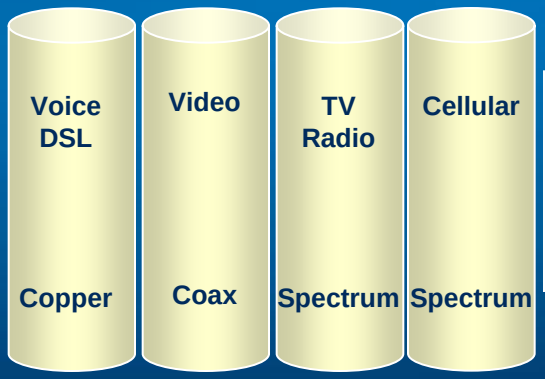
Mobile Internet Requires a Technology Revolution

* Source: Cisco Visual Networking Index, July 2009

Governments' Dilemma

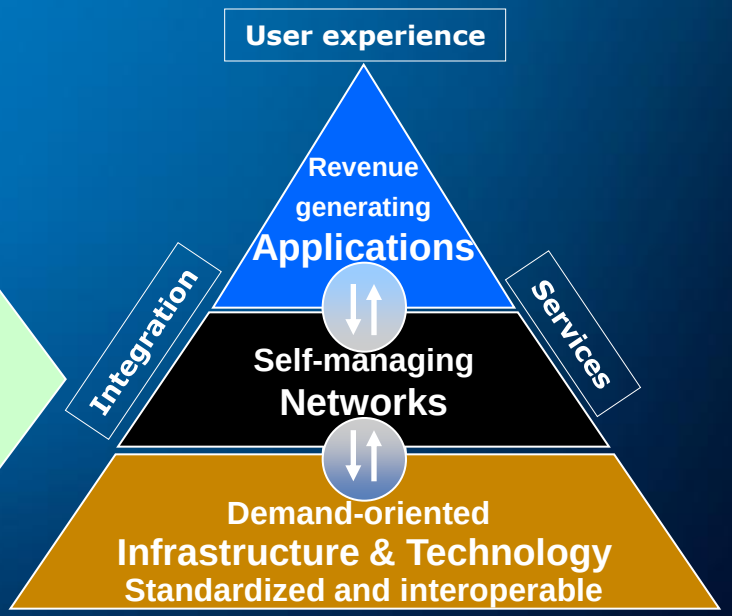
Farewell industries

- **Consumer electronics in 70ties**
- **Mainframes in 80ties**
- **Landline telecommunication in 90ties**
- **Broadband telecommunication in 00ties?**
- **Automobile industry in 10ties?**



Changing the mindset and social tensions:

- **in national economies**
- **in incumbent organisations**

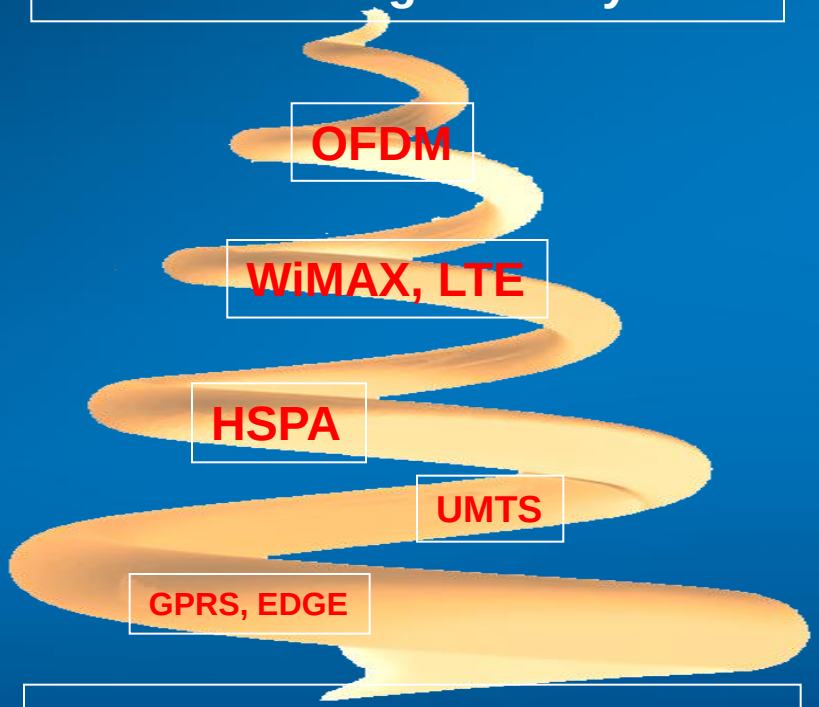


Broadband enables new industries

What needs to be done?

Network and business model evolution

OFDM
One broadband network for all:
Delivering bits only



GSM:
One narrow band network for all
Delivering voice only

Throughput optimised networks
Operators without network (Apple)

Fragmented networks
de-monopolisation

Incumbents: Monopolistic operators

From voice to bits: ubiquitous service

Reconsider Spectrum Philosophy

Radio Technologies: service specific

- **Broadcasting bands:** AM, FM, DAB, DVB-T
- **Voice bands:** GSM, UMTS, etc.
- **Data band:** 802.11x

Content: Broadcast, Voice, Data

OFDM Radio Technologies

- **Coverage/mobile** Bands < 1 GHz
  - Channel Bandwidth ≤ 5 MHz
    - Rate ≤2 Mbit/s
- **Cellular/mobile** 1 GHz < bands < 2 GHz
  - Channel Bandwidth ≤ 10 MHz
    - Data Rate ≤100 Mbit/s
- **Capacity/portable** 2 GHz < bands
  - Channel Bandwidth ≤ 100 MHz
    - Pico: Data Rate ≤1 Gbit/s

Digital Dividend

Example Germany:

Promise to cover remaining ~10% of population with BWA using DD
Missing BA hamper establishment of enterprises in rural areas

DD: 790-862 MHz as result of WRC-07 arranged with 2x30 MHz + 12 MHz

A radio cell with 10 km radius covers 314 km^2 area

Let's assume 300 enterprises in this cell requiring 10 Mbit/s transfer rate every

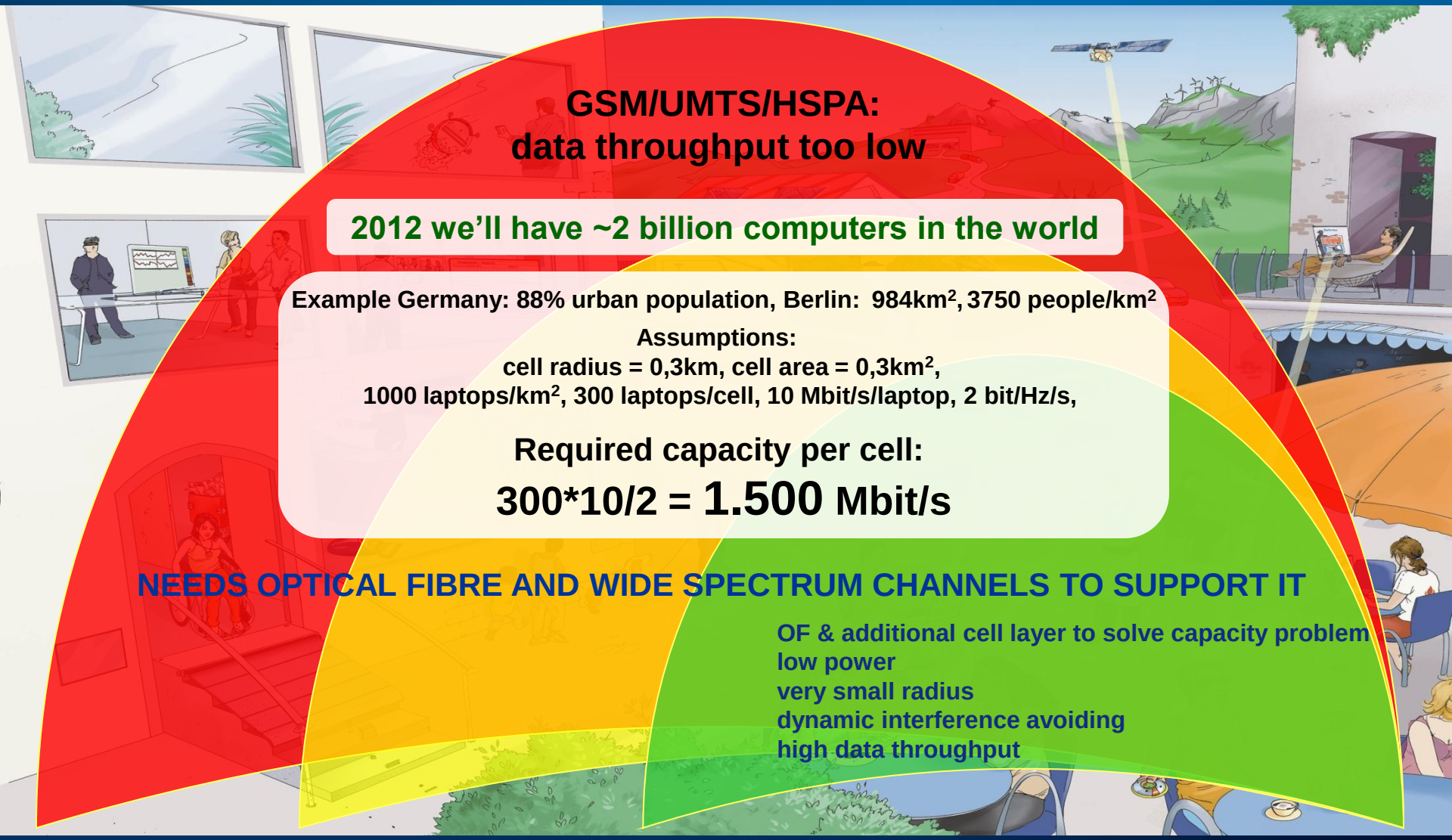
This cell must provide 3.000 Mbit/s of continuous transmit in 30 MHz bandwidth

State of the art – HSPA – offers ~15 Mbit/s in 5 MHz bandwidth in 500 m radius

Broadband Wireless Access is not coverage limited

It is capacity limited!

Capacity Scenario Deployment



GSM/UMTS/HSPA:
data throughput too low

2012 we'll have ~2 billion computers in the world

Example Germany: 88% urban population, Berlin: 984km², 3750 people/km²

Assumptions:
cell radius = 0,3km, cell area = 0,3km²,
1000 laptops/km², 300 laptops/cell, 10 Mbit/s/laptop, 2 bit/Hz/s,

Required capacity per cell:

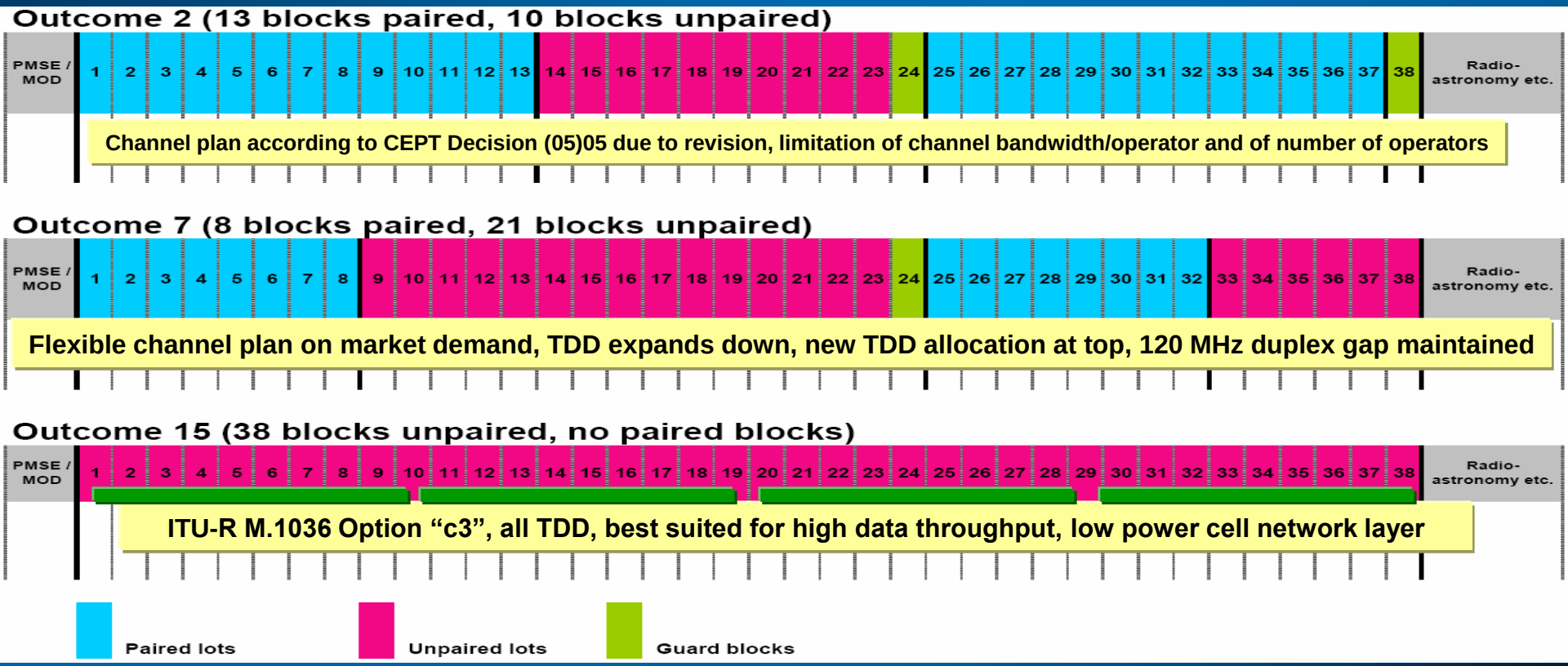
300*10/2 = 1.500 Mbit/s

NEEDS OPTICAL FIBRE AND WIDE SPECTRUM CHANNELS TO SUPPORT IT

OF & additional cell layer to solve capacity problem
low power
very small radius
dynamic interference avoiding
high data throughput

Current network and spectrum concepts need improvement to support broadband

2.5 GHz Spectrum arrangement

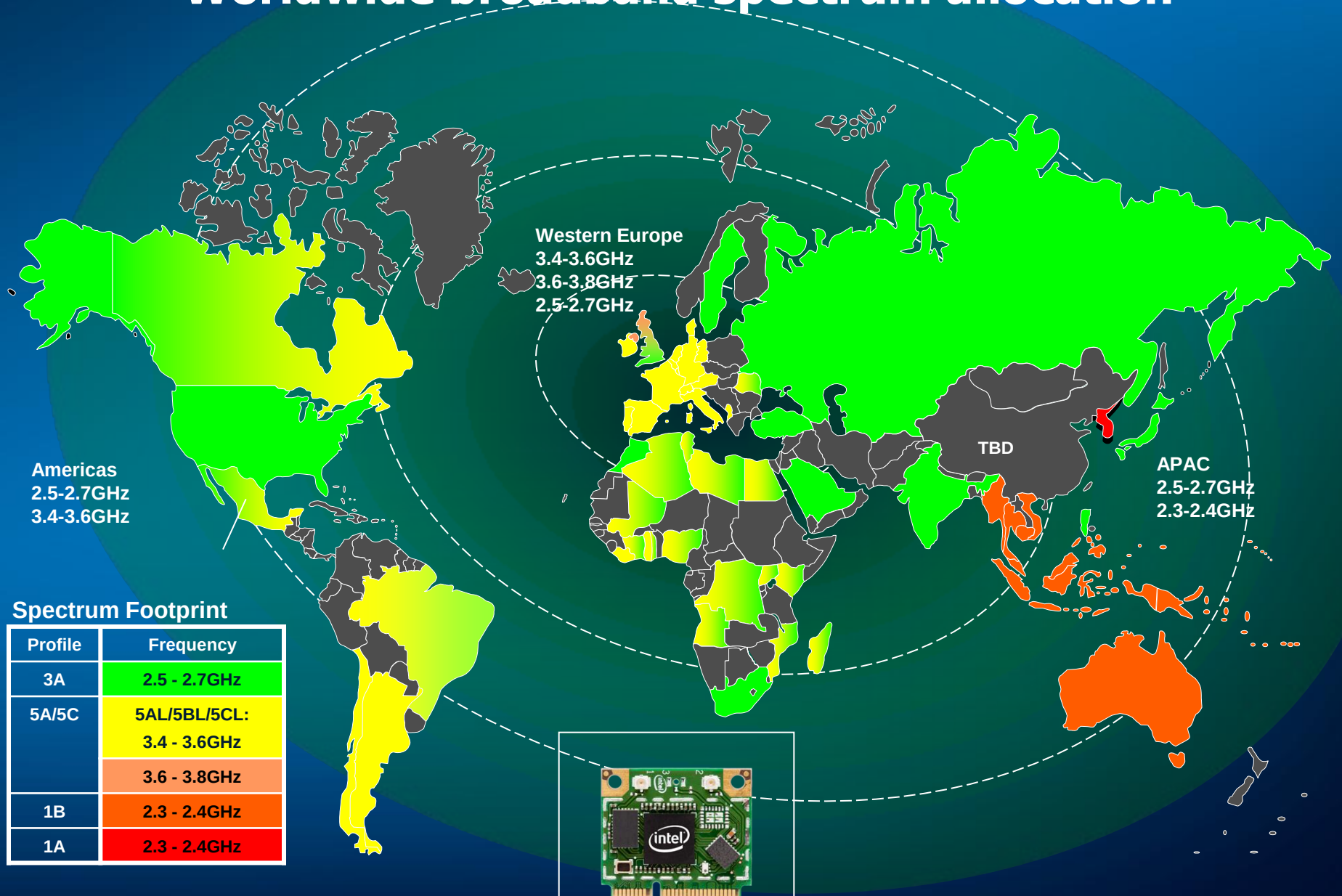


In Europe there are two legally incompatible decisions:

1. 2008/477/EC: COMMISSION DECISION of 13 June 2008 on the harmonization of the 2 500-2 690 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community
2. ECC/DEC/(05)05: ECC Decision of 18 March 2005 on harmonized utilization of spectrum for IMT-2000/UMTS systems operating within the band 2500 – 2690 MHz

Let markets arrange the FDD/TDD split in 2.6 GHz band

Worldwide broadband spectrum allocation



Spectrum Footprint

Profile	Frequency
3A	2.5 - 2.7GHz
5A/5C	5AL/5BL/5CL: 3.4 - 3.6GHz
	3.6 - 3.8GHz
1B	2.3 - 2.4GHz
1A	2.3 - 2.4GHz

Kilmer Peak

[1]Applies to TDD Spectra
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Thank You