



Telecommunication Futures: A 360° View

**Adam T. Drobot
President and CTO
Telcordia Technologies, Inc.
Piscataway, NJ 08854
USA**



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Setting the Stage

1. The ICT industry
2. Global trends
3. The role of technology
4. What will 5G & 6G look like?
5. The shape of the industry & the underlying infrastructure
6. Customers and institutions
7. Life for workers in telecommunications
8. Regulation and governance
9. Conclusion



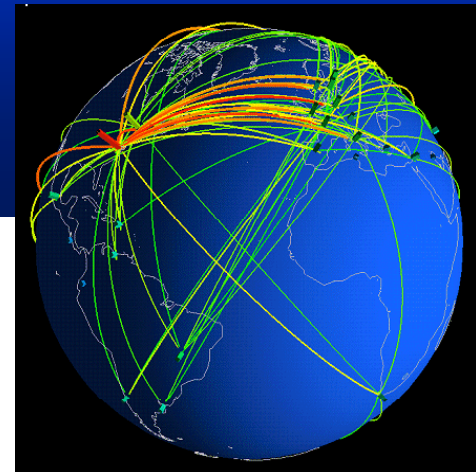
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The ICT Industry

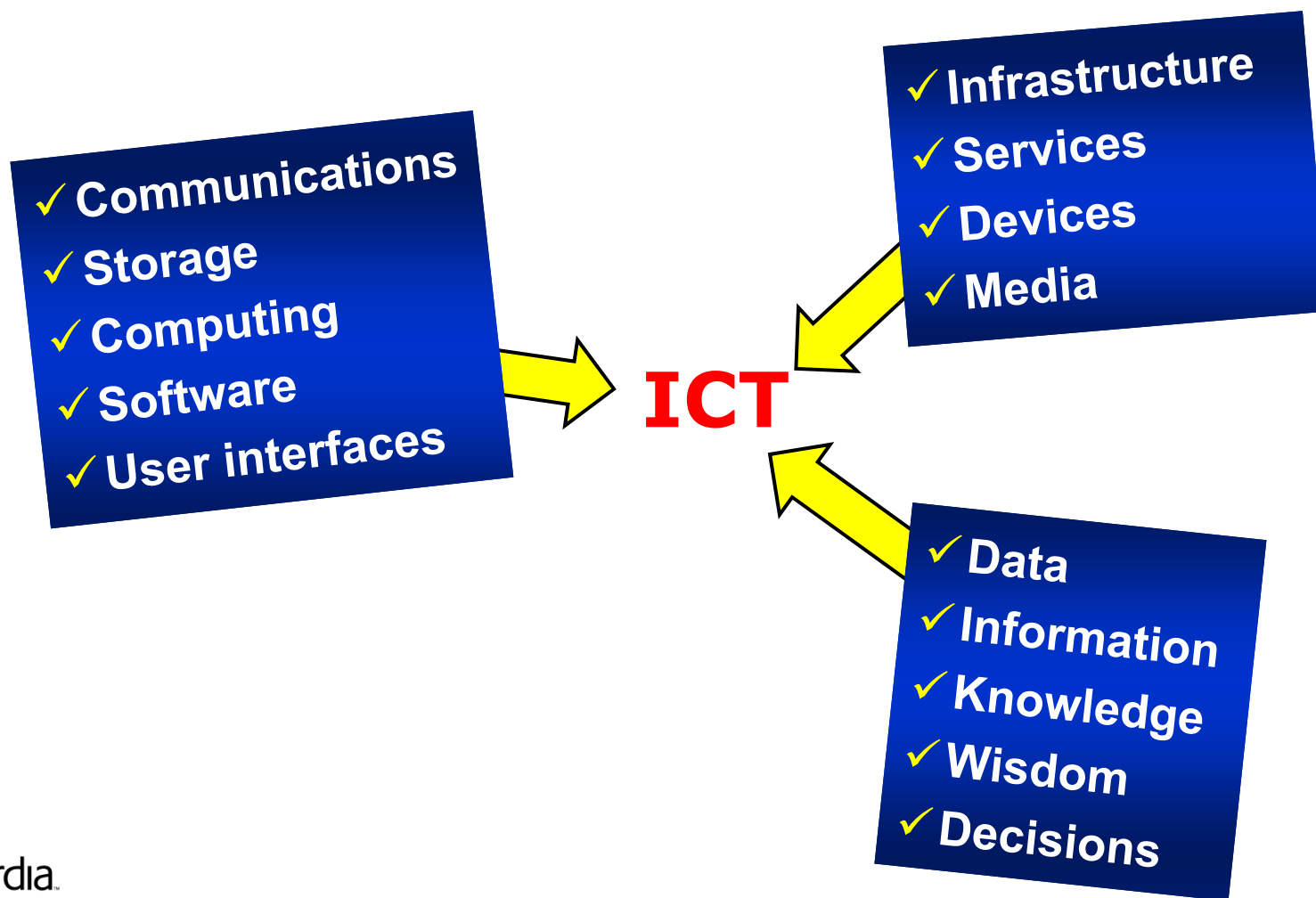
Information & Communication Technology

- End-to-end ...
 - from the communications at the bottom of the stack
 - to media and applications at the top
- In the US, it's 7% of GDP and still growing!



The ICT Industry

- Key ingredients



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Global Trends: World View over 13 Years

- **153 countries, 1995 – 2007**

- ❖ **Fixed telephone lines**
- ❖ **Mobile subscribers per 100 population**
- ❖ **Internet subscribers per 100 population**
- ❖ **Broadband users per 100 population**

Data source: ITU World Telecommunication Indicators 2008

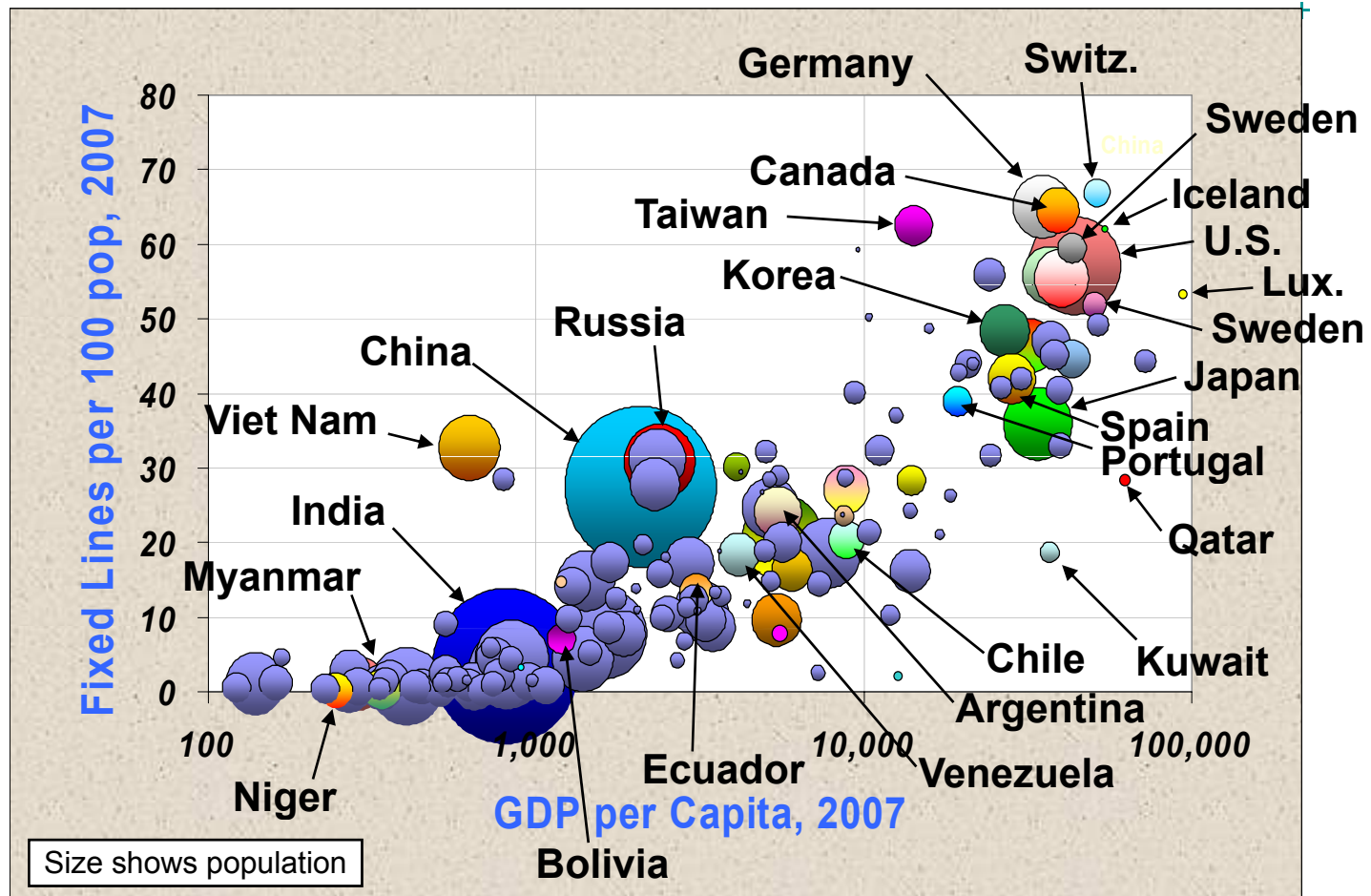
Global Trends – Fixed Lines

Fixed Telephone Lines

Data source: ITU World Telecommunication Indicators 2008

Global Trends

Fixed Telephone lines per 100 pop. in 2007



Data source: ITU World Telecommunication Indicators 2008

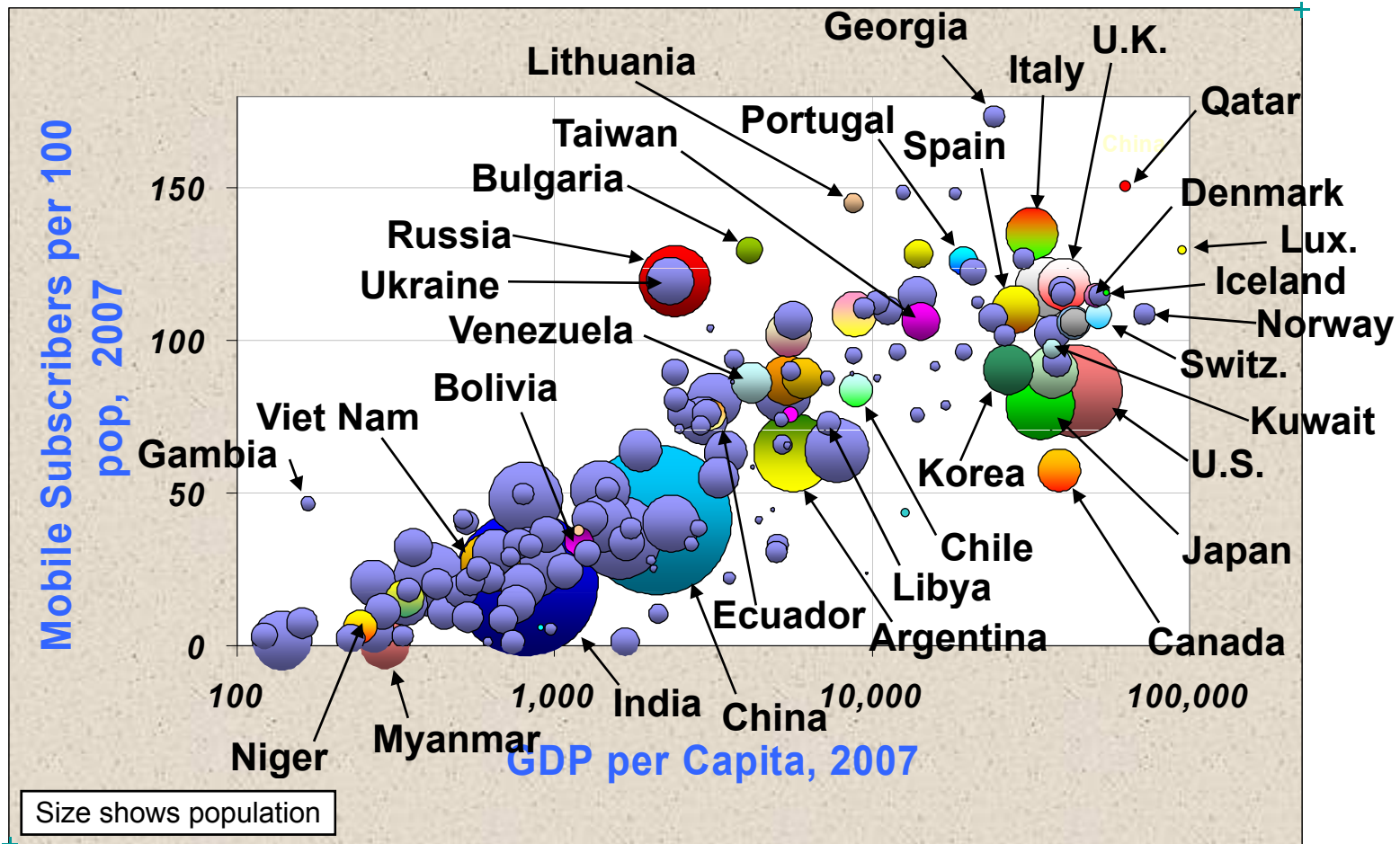
Global Trends – Mobile Subscribers

Mobile Subscribers

Data source: ITU World Telecommunication Indicators 2008

Global Trends

Mobile Subscribers per 100 pop. in 2007



Data source: ITU World Telecommunication Indicators 2008

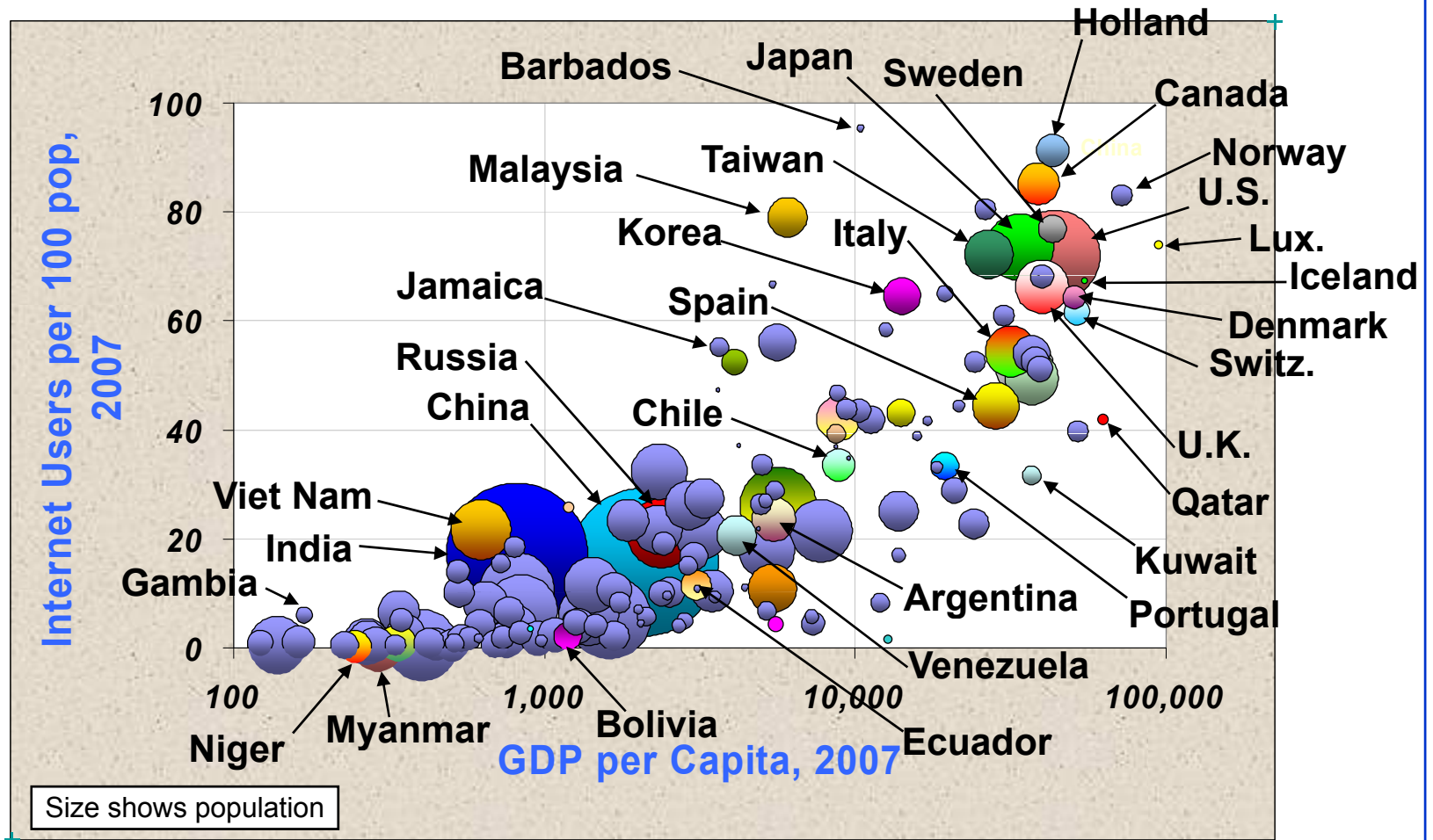
Global Trends – Internet Users

Internet Users

Data source: ITU World Telecommunication Indicators 2008

Global Trends

Internet Users per 100 pop. in 2007



Data source: ITU World Telecommunication Indicators 2008

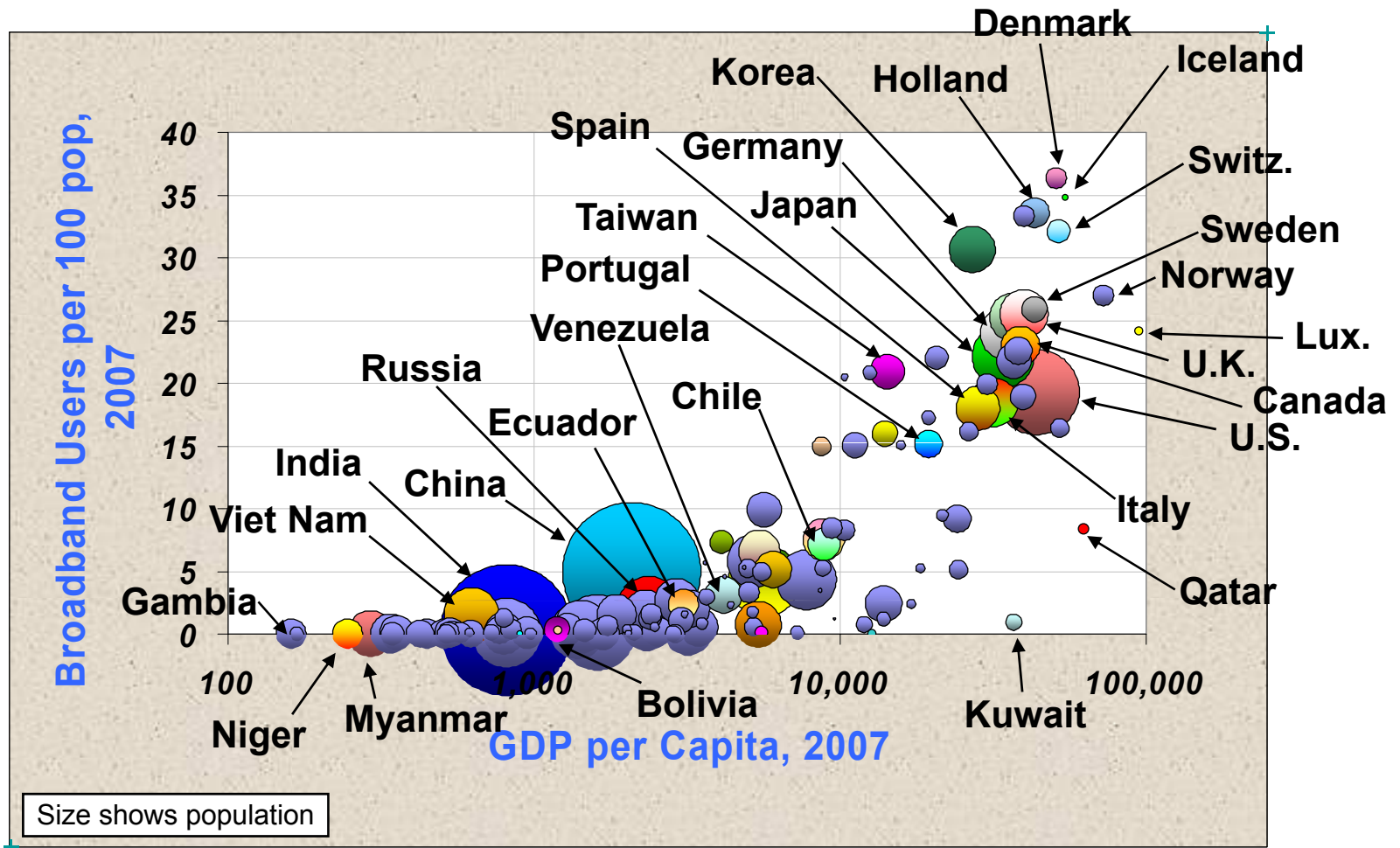
Global Trends – Broadband Users

Broadband Users

Data source: ITU World Telecommunication Indicators 2008

Global Trends

Broadband Users per 100 pop. in 2007



Data source: ITU World Telecommunication Indicators 2008

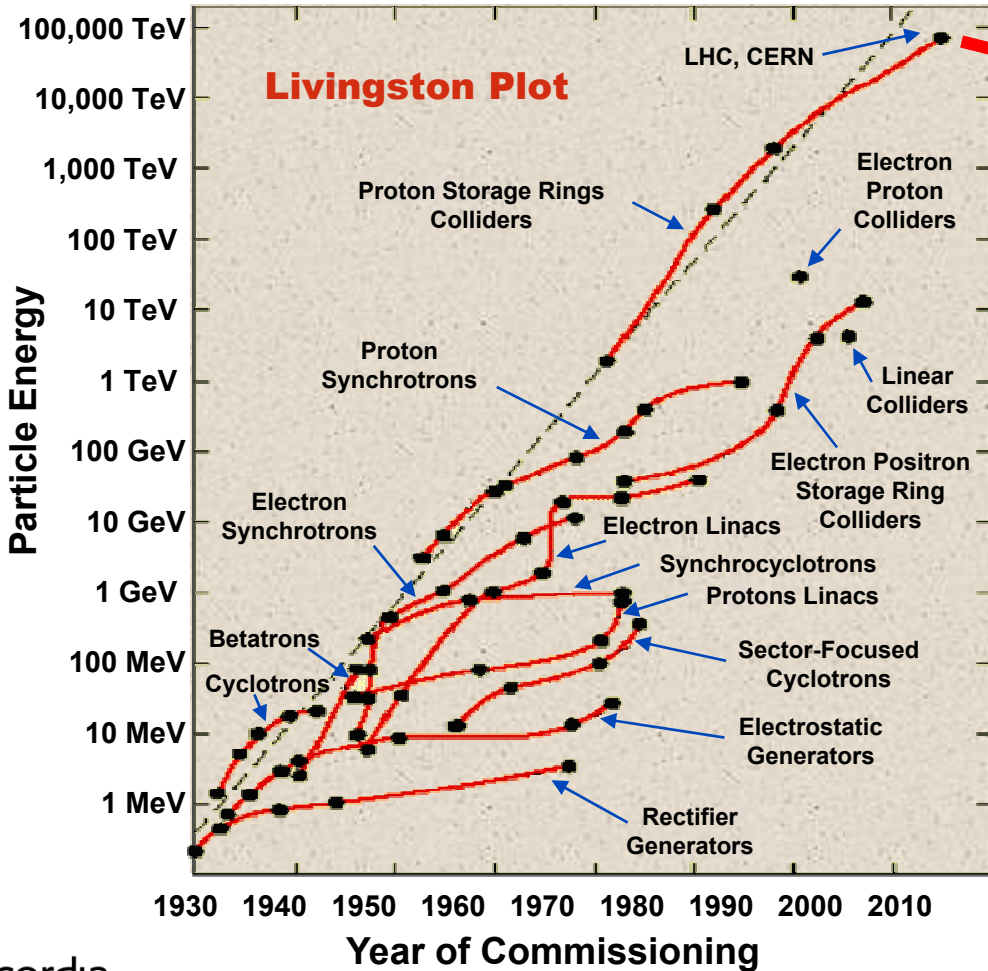
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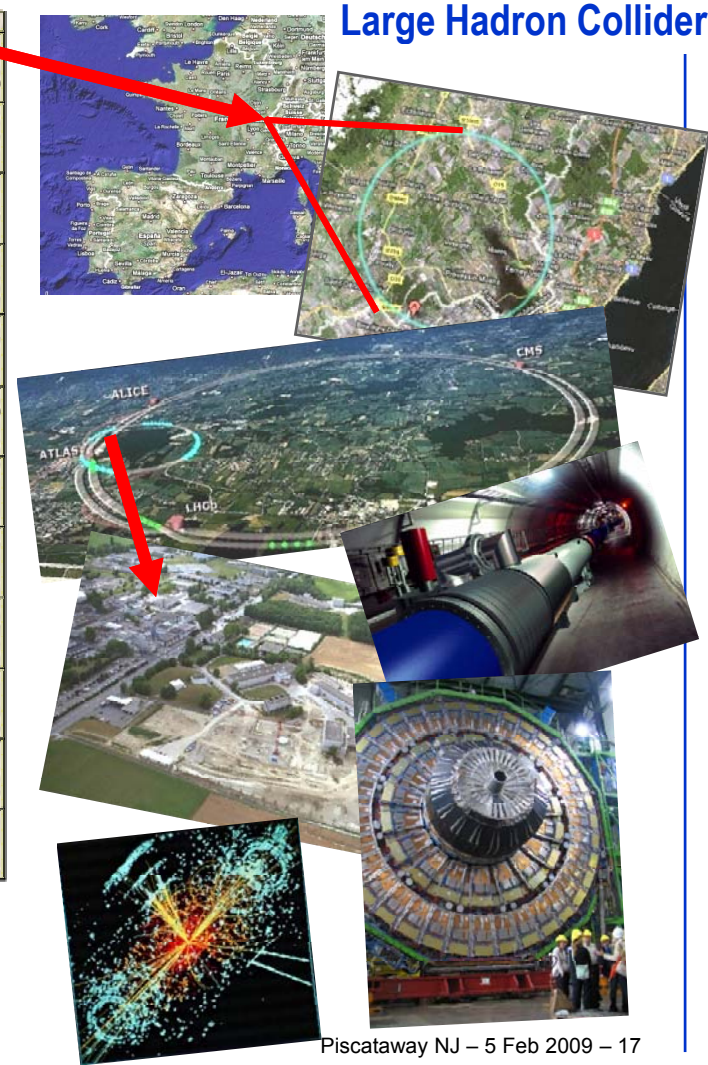


Role of Technology – Technology Curves

A “Livingston curve” showing the evolution of accelerator energy from 1930 until 2005. Energy of colliders is plotted in terms of the energy of particles colliding with a proton at rest to reach the same center of mass energy.

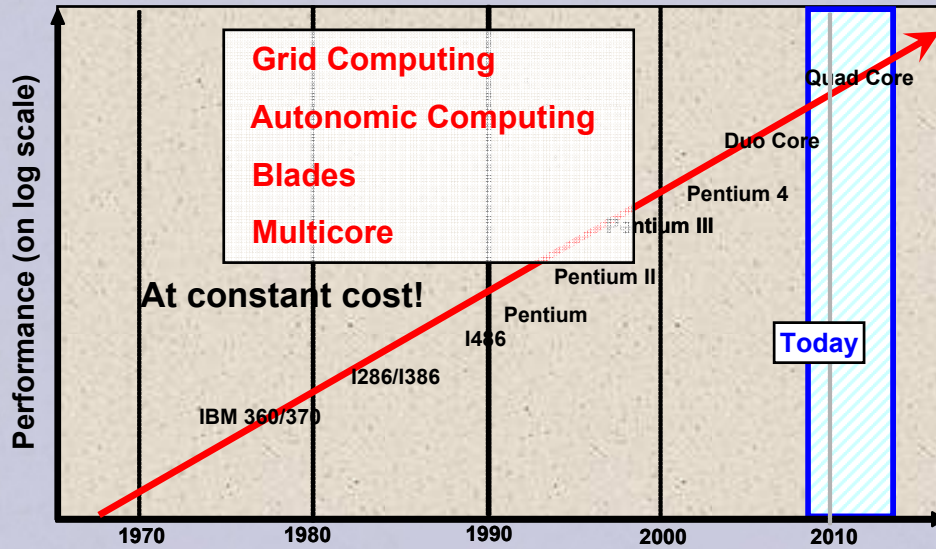


Large Hadron Collider

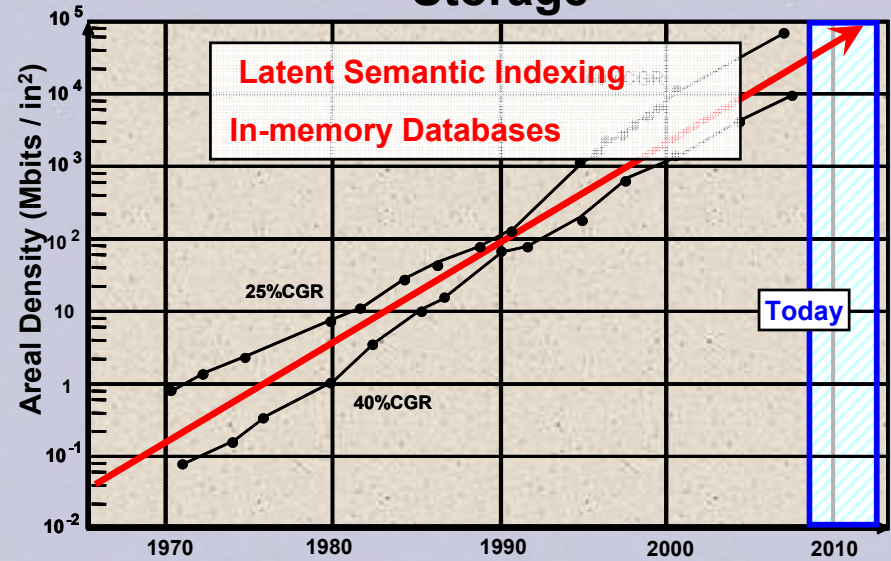


Role of Technology – Computing & Storage

Computing

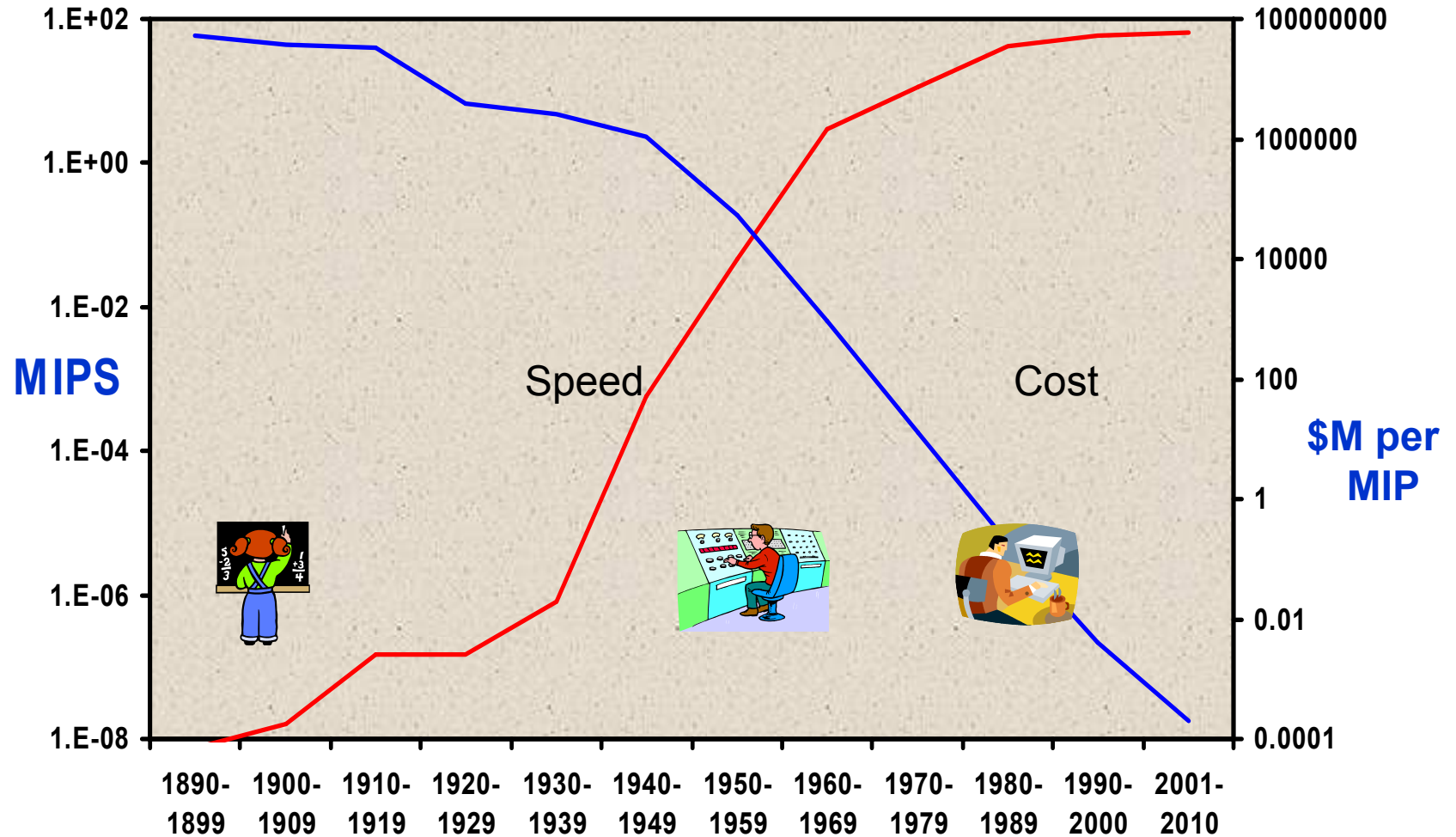


Storage



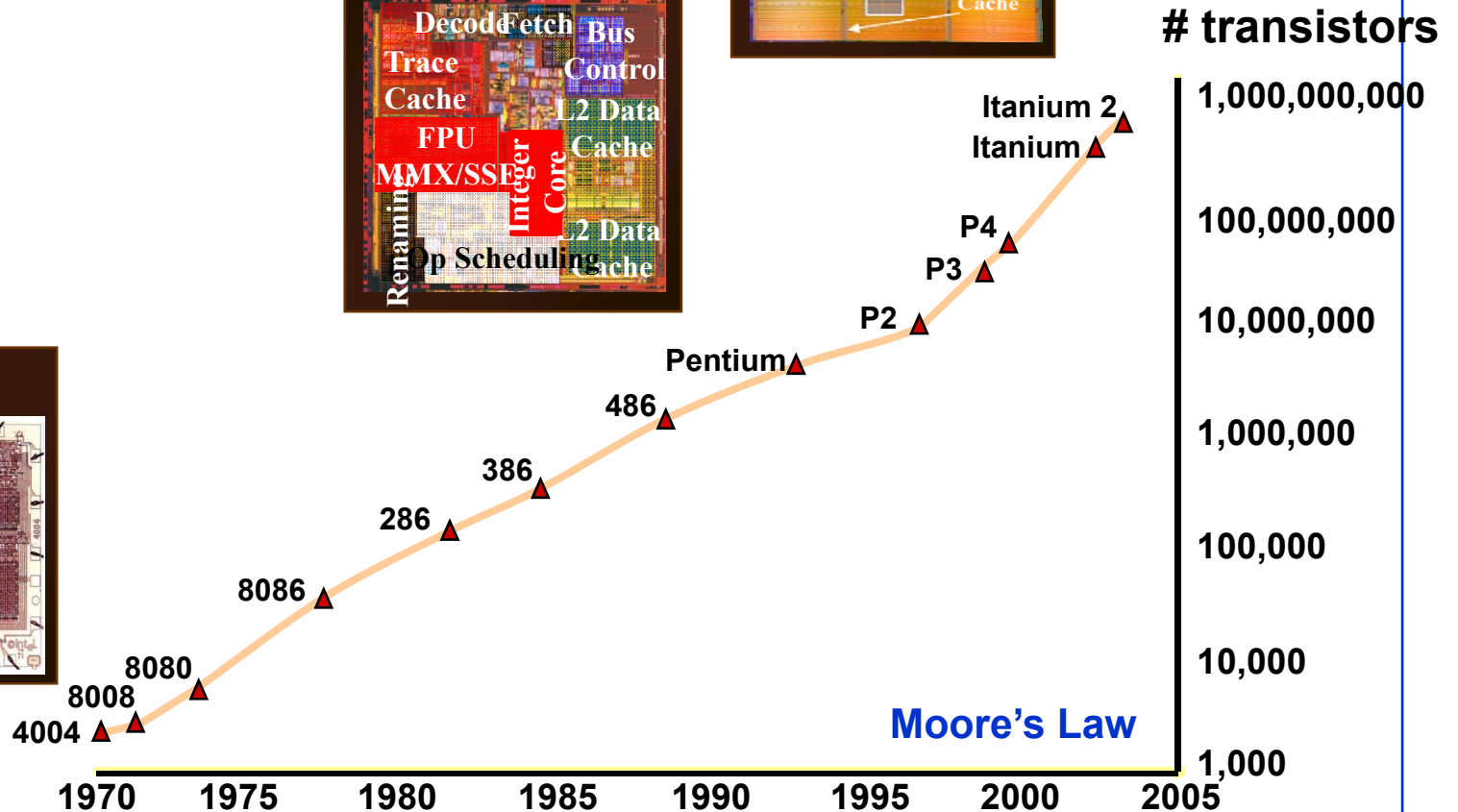
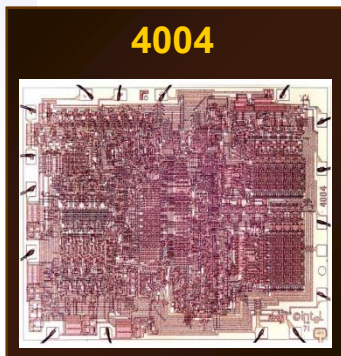
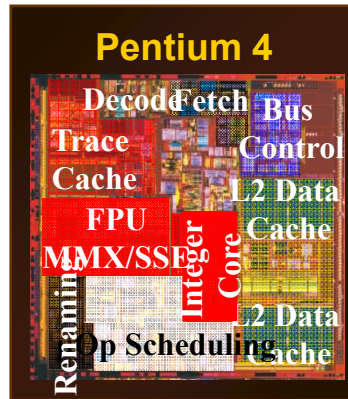
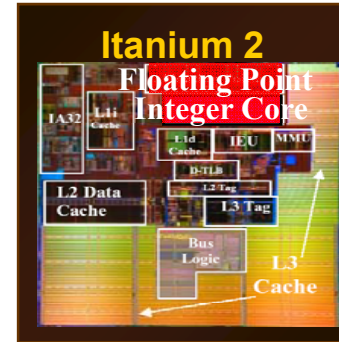
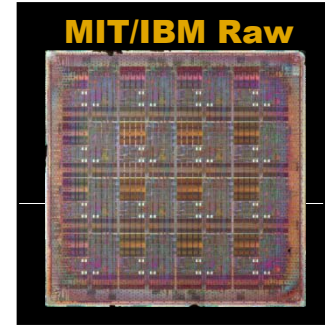
Role of Technology – Computing

Speed and Cost



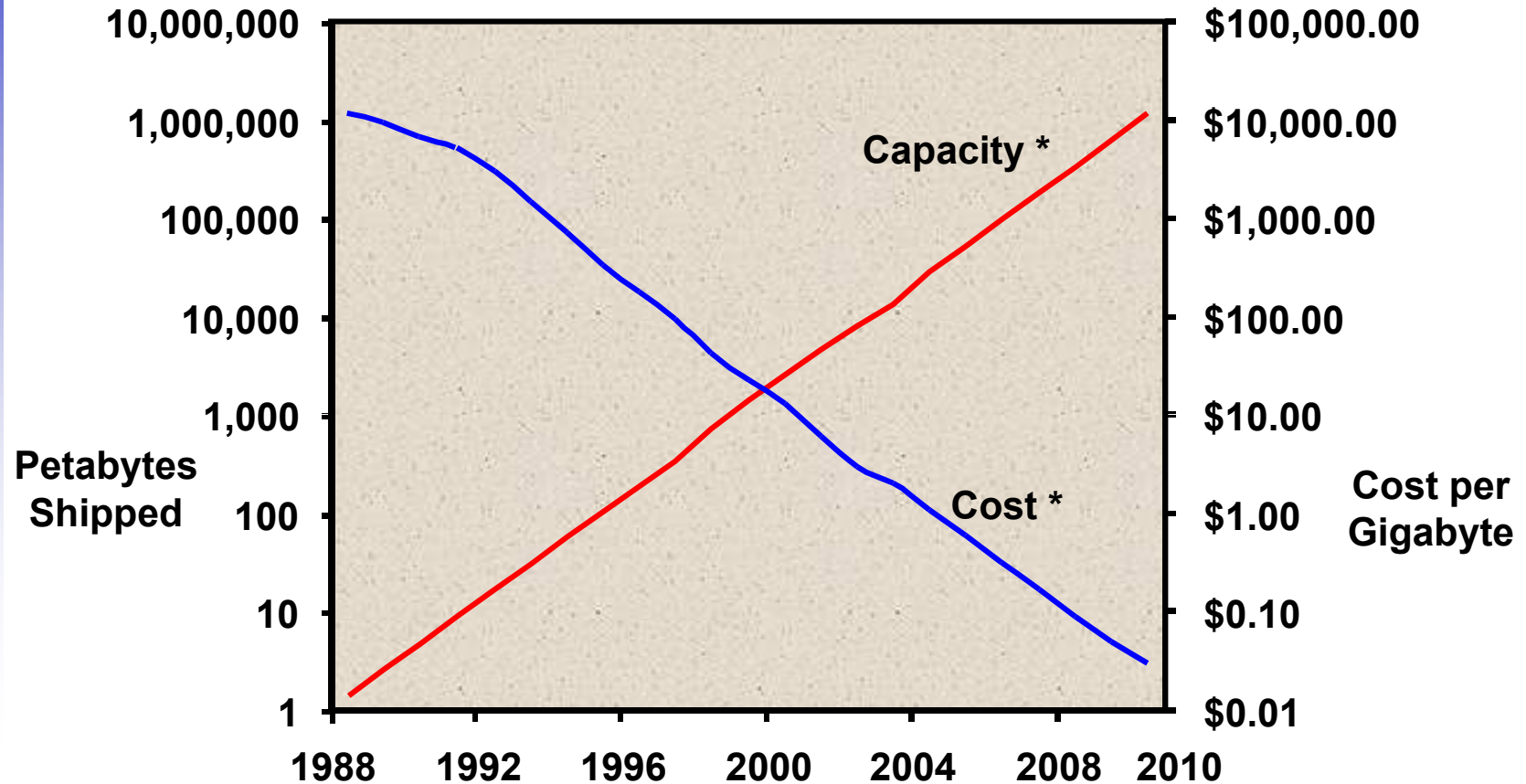
Role of Technology – Moore’s Law:

From single transistors to CMP



Role of Technology – Storage

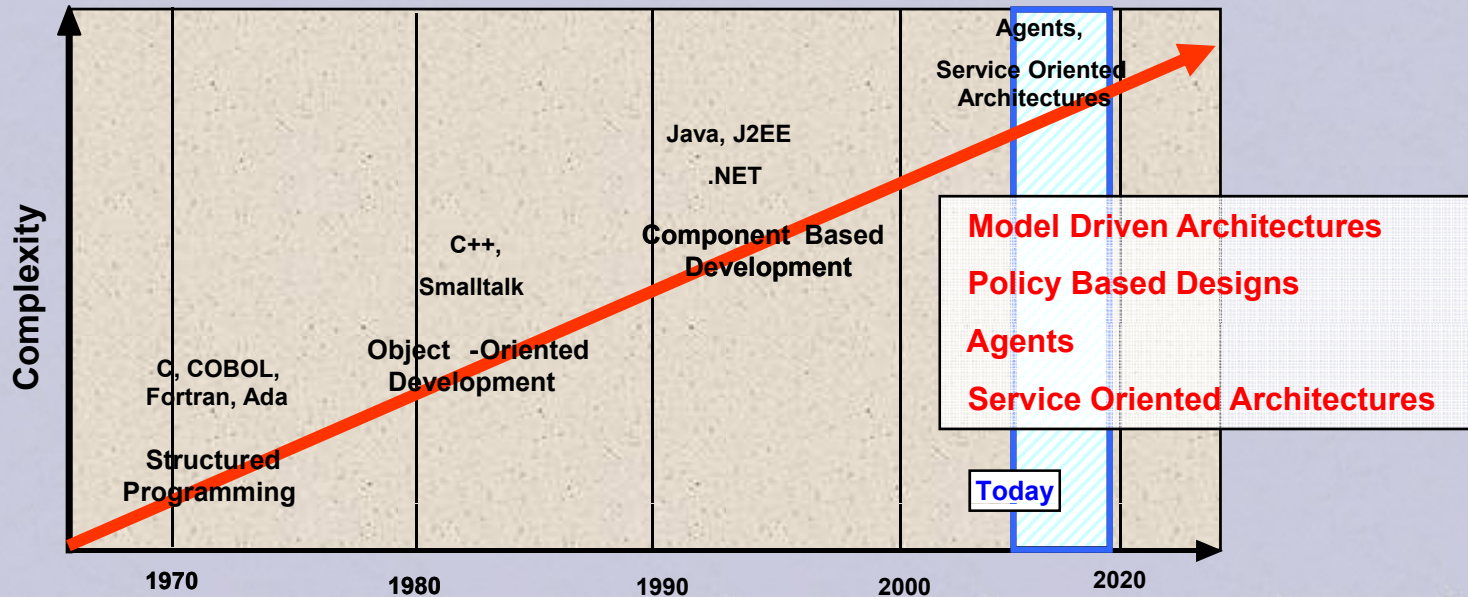
Capacity and Cost



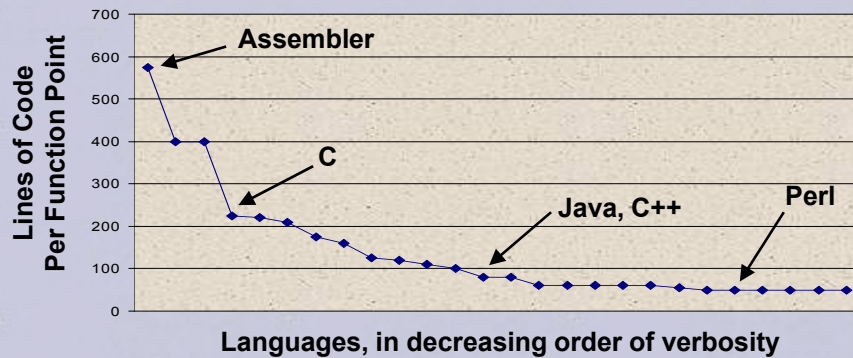
Sources: IDC, "1999 Winchester Disk Drive Market Forecast and Review," Wall Street Journal, June 26, 2000

*Telcordia projected capacity 1988-1994 & costs 2003-2010.

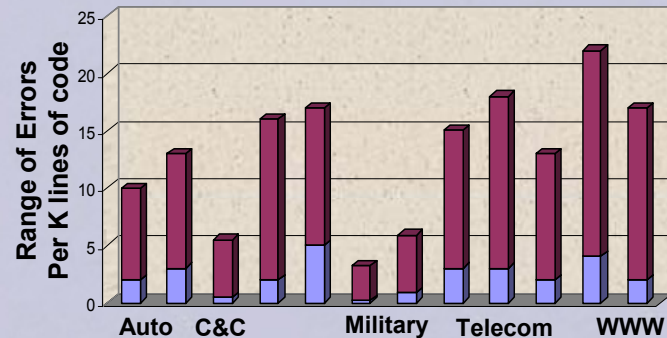
Role of Technology – Software



Programming Language Evolution

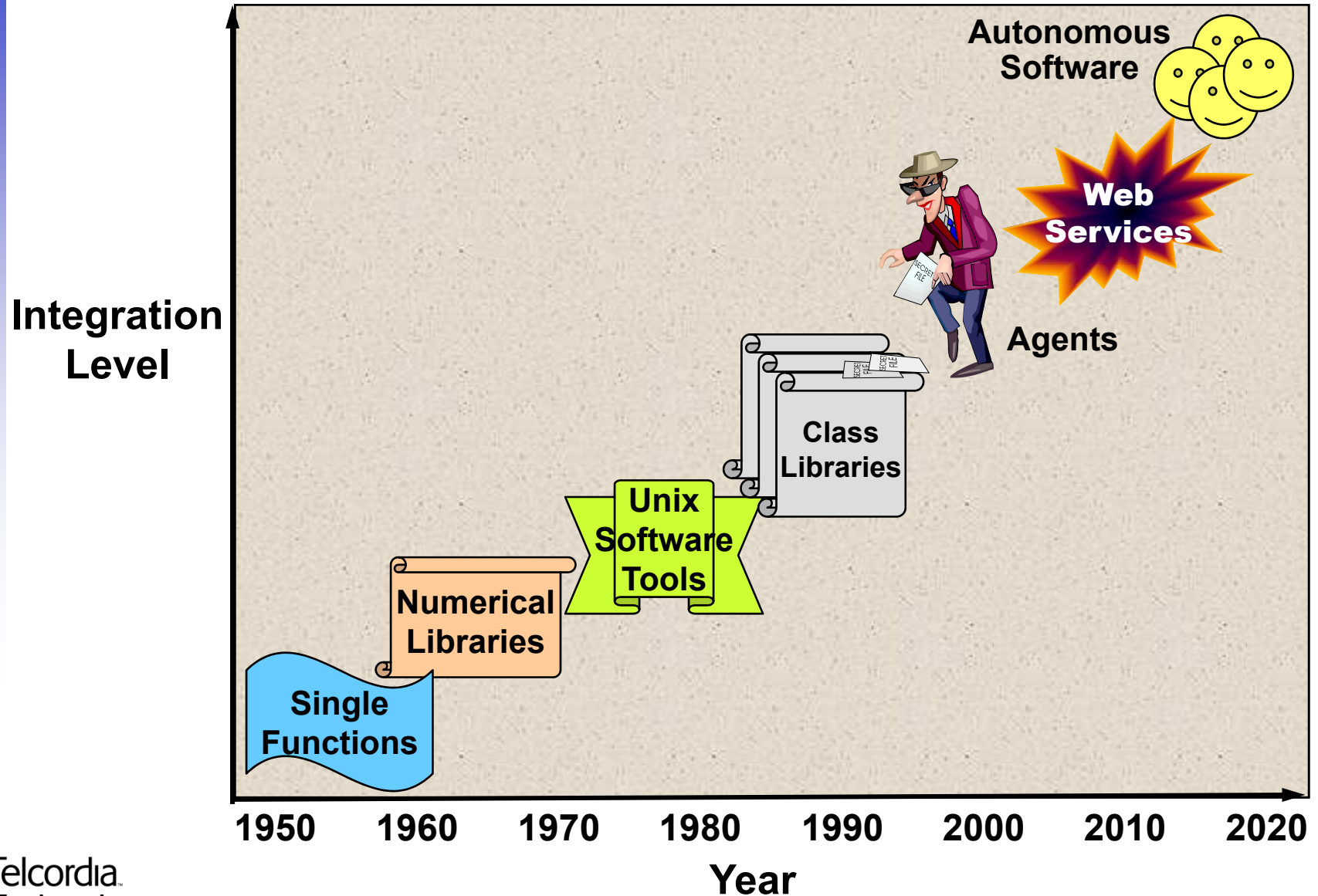


Software Quality by Industry



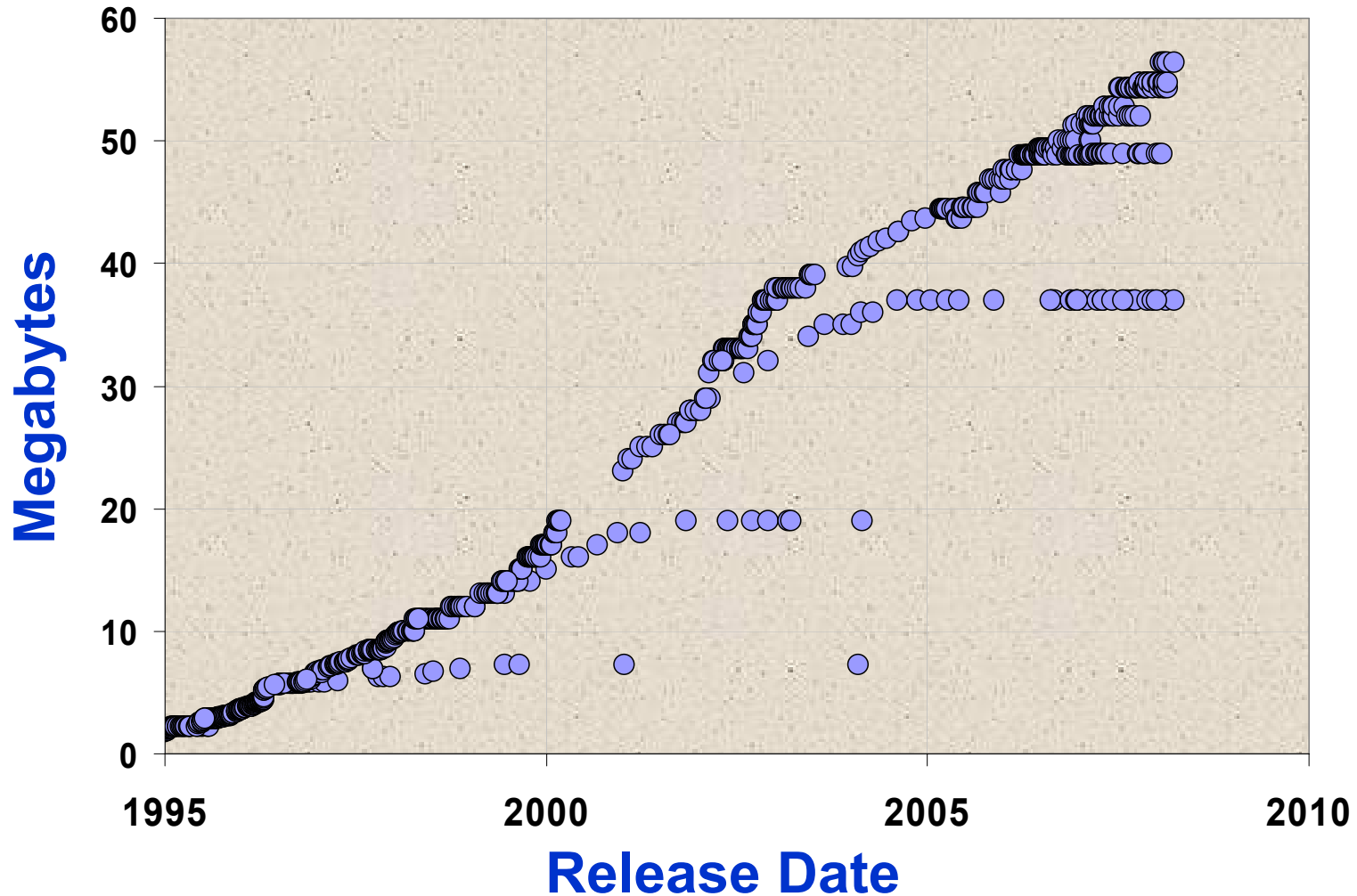
Role of Technology – Software

Integration Level



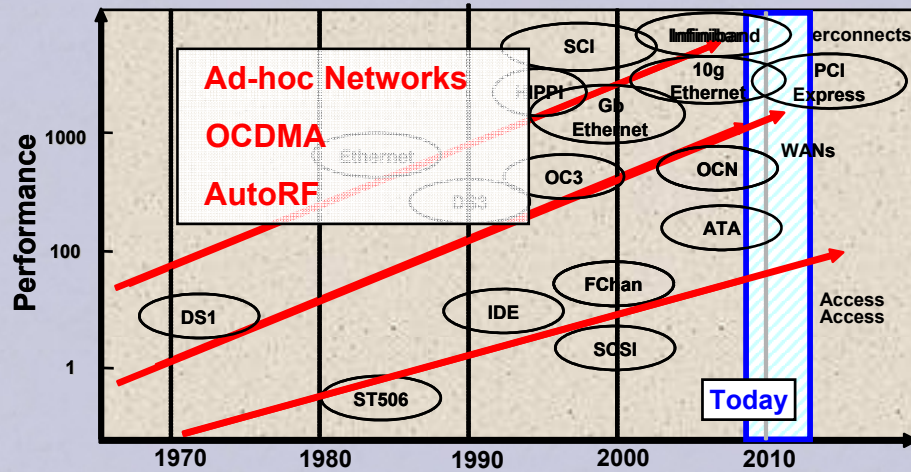
Role of Technology – Software Complexity

Size of Linux Kernel across Releases

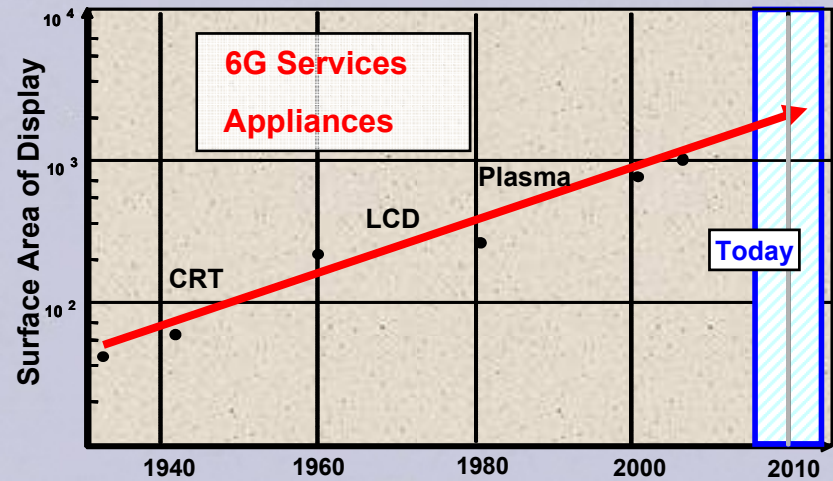


Role of Technology – Networks & Interfaces

Networks

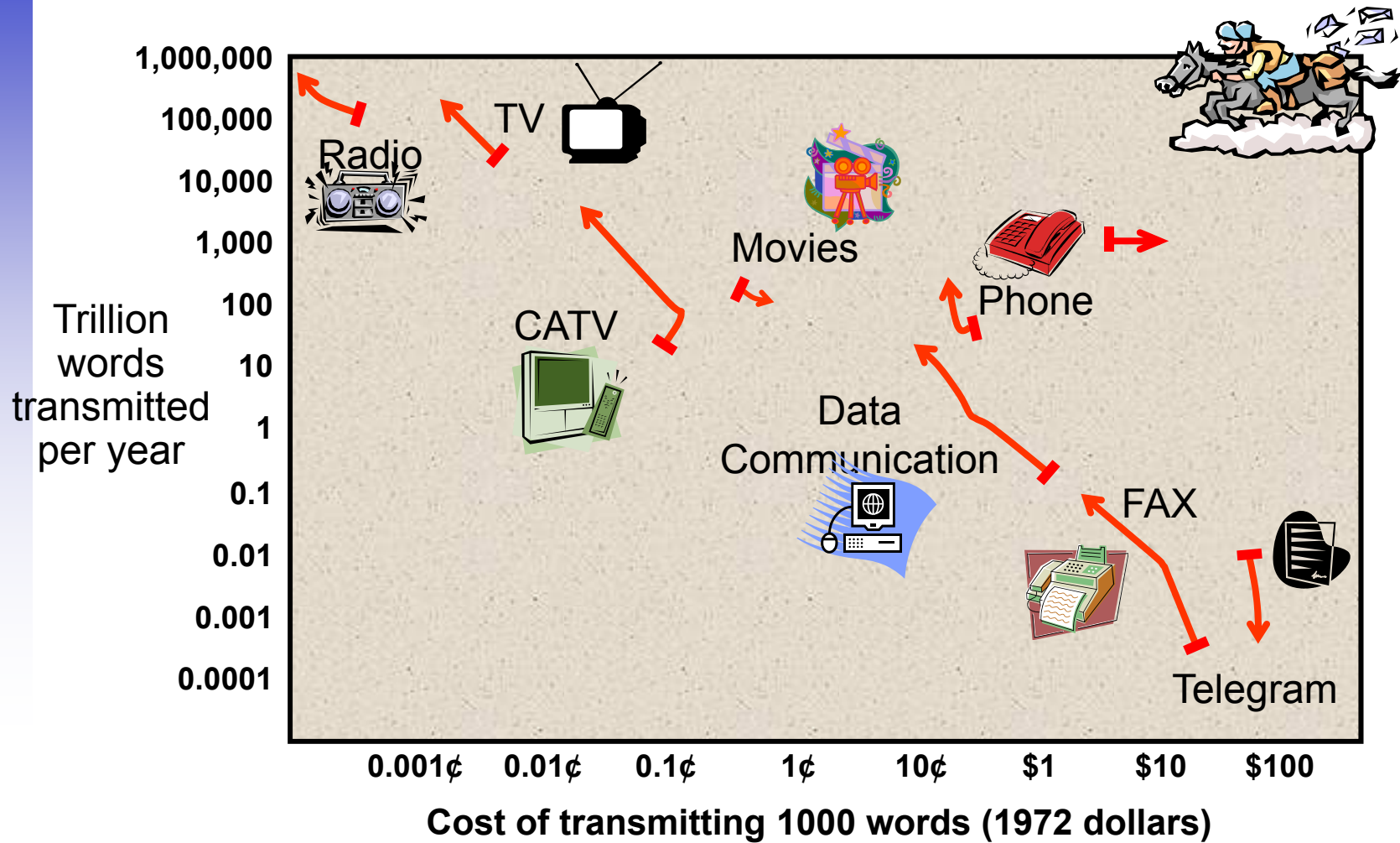


User Interfaces



Role of Technology – Content Delivery

Quantity and Cost (USA 1960 - 2009)



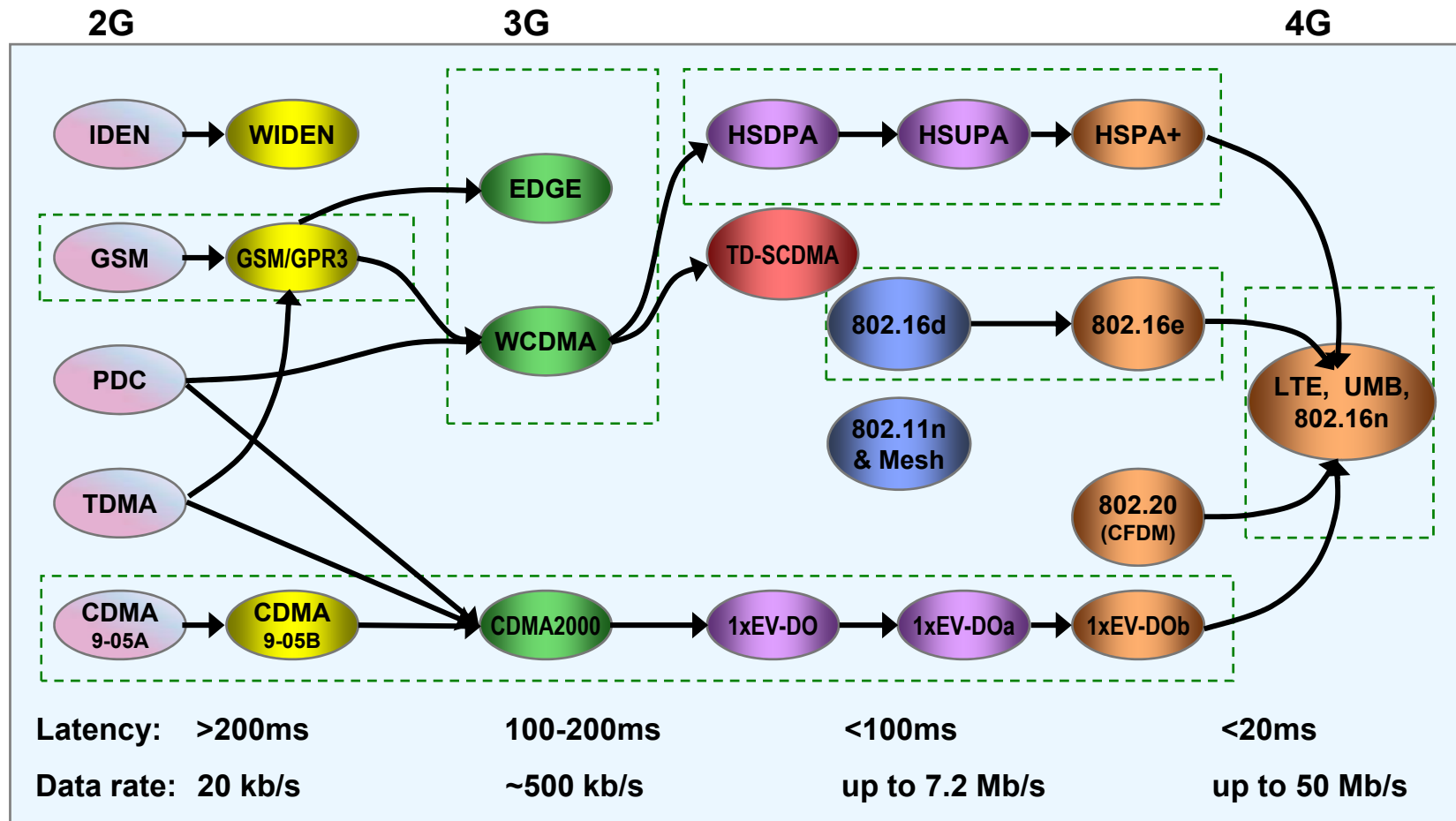
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What will 5G & 6G look like?

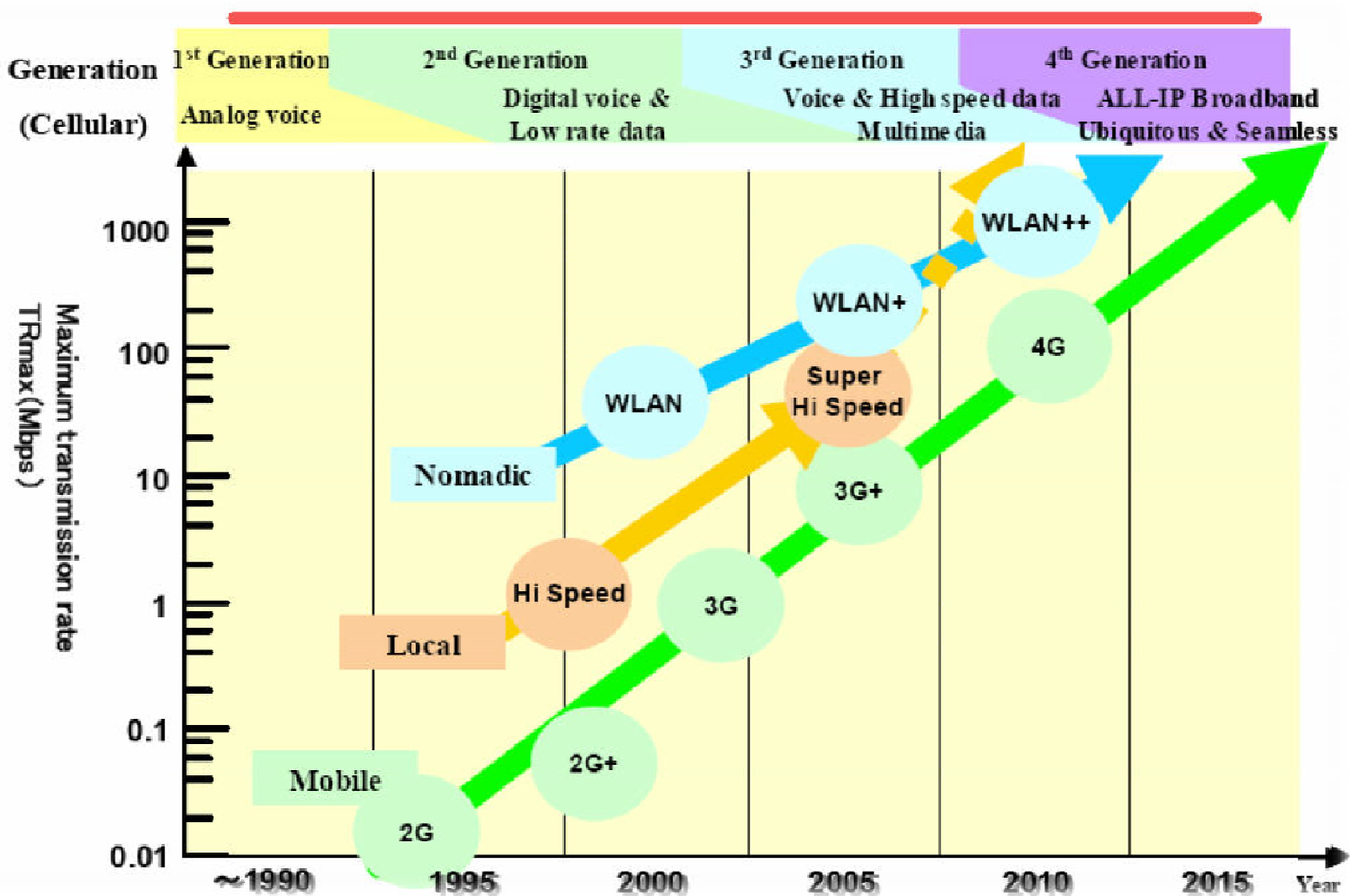
Cellular Technology Evolution: 2G, 3G, 4G...



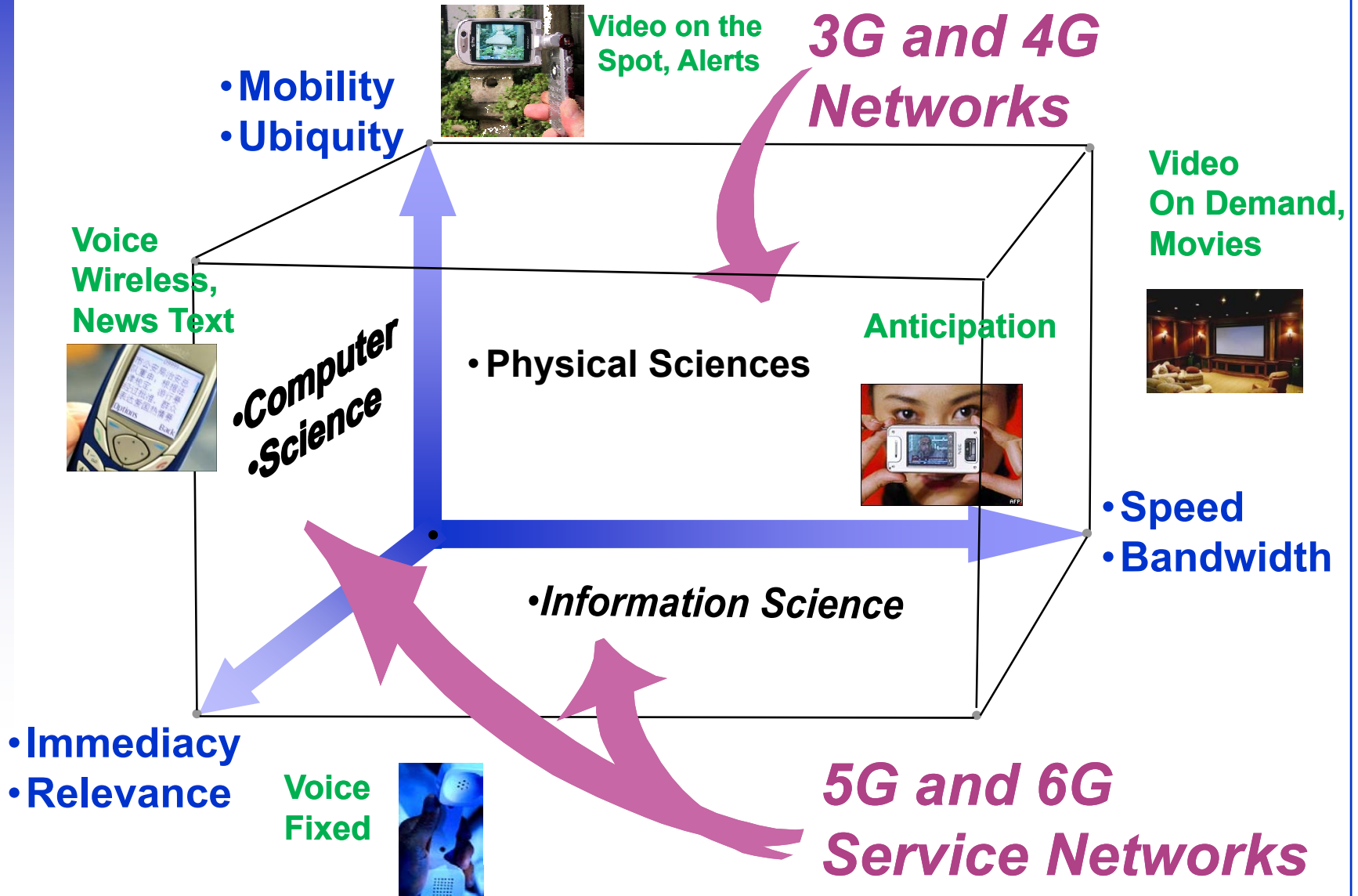
Source: Deutsche Bank (March 2008)

What will 5G & 6G look like?

Another nG Roadmap



What will 5G & 6G look like? – Research

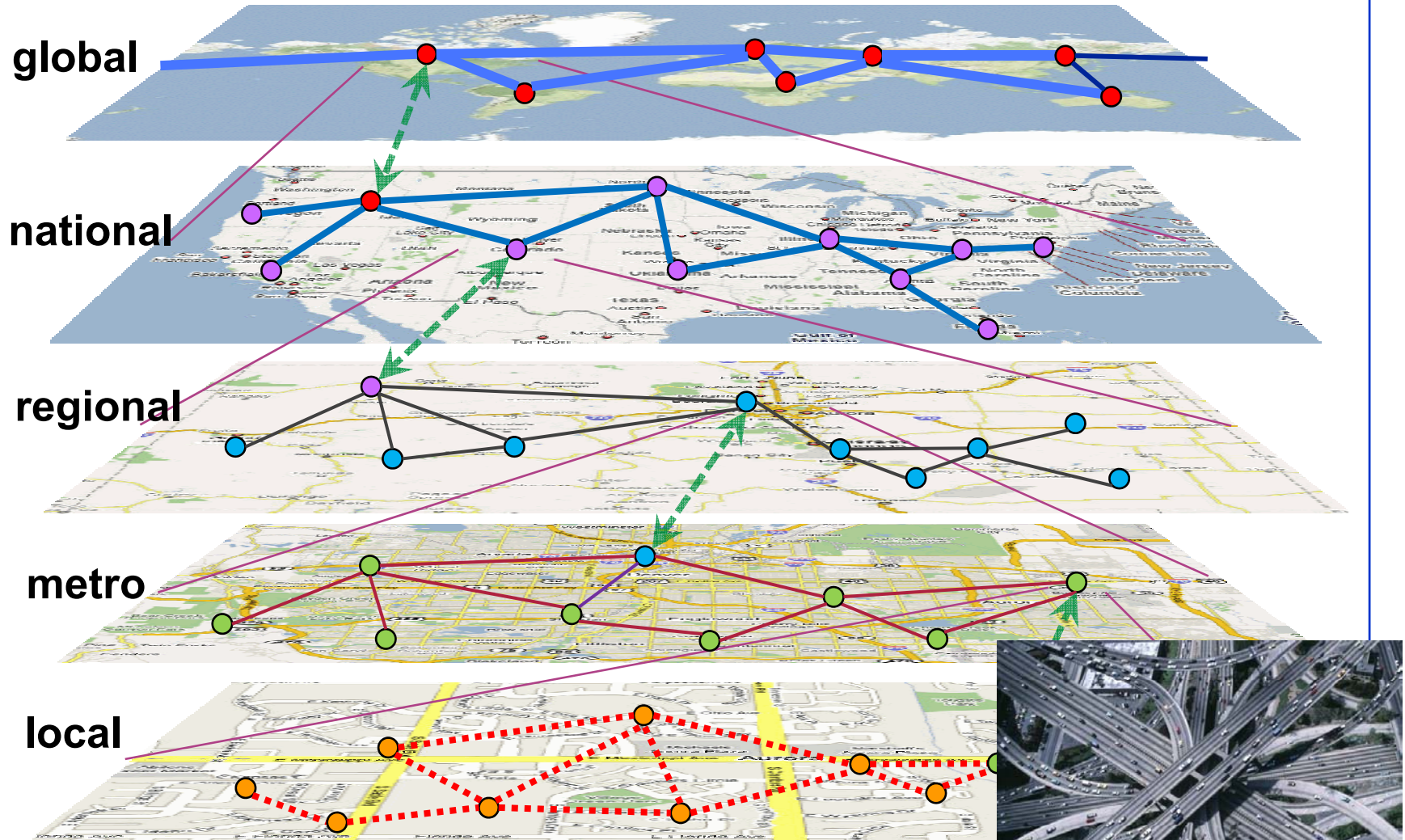


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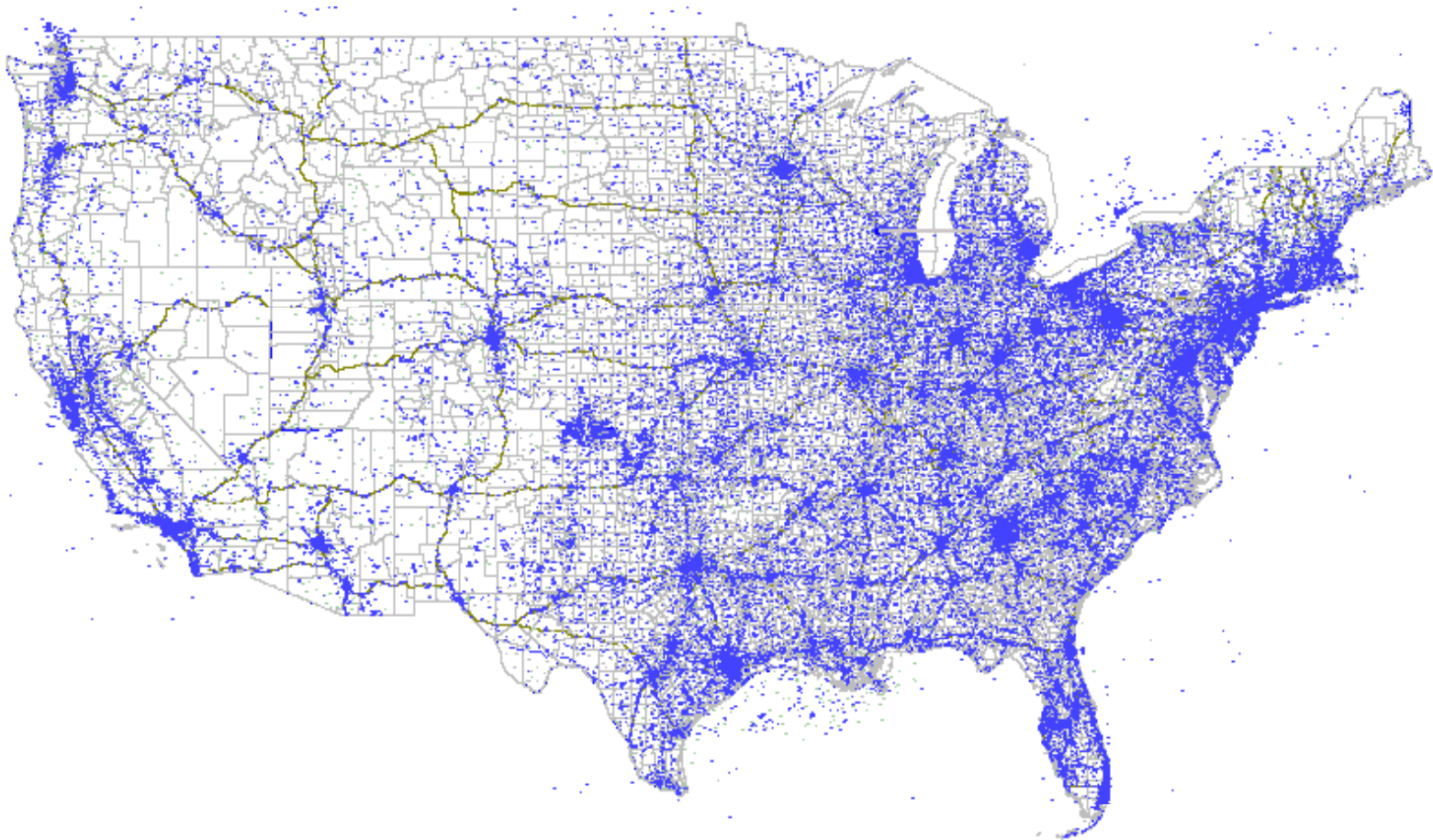


Shape of the industry & underlying infrastructure: Network Layers



Shape of the industry & underlying infrastructure

Locations of cellular towers in the US



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Customers and Institutions



■ Customers

- Consumers
- Small to mid enterprises
- Corporate Enterprises
- Government , state, local
- Military
- Education
- Health care

■ Service Providers

- Supply chain of capabilities

■ Original equipment manufacturers

- Supply chain of components

■ Media Industry

- Creative talent
- Advertising

■ Support Infrastructure

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Life for workers in telecommunications

People

- Industry is global
- Change is a constant
- Roles, responsibilities, authority, culture

Tools

- Power applications
- Automation
- Devices
- Access
- Modes of interaction

Processes

- Open
- Visible
- Cross-connected



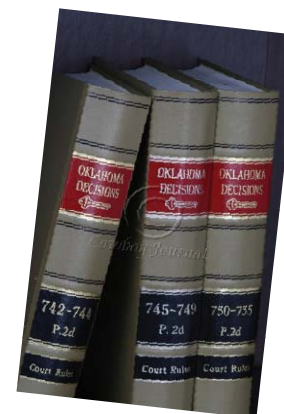
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Regulation and Governance

- **Formal – regulatory**
 - International
 - National
 - Local
- **Standards**
 - Codified
 - De facto
 - Consensus
- **Markets**



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Conclusion

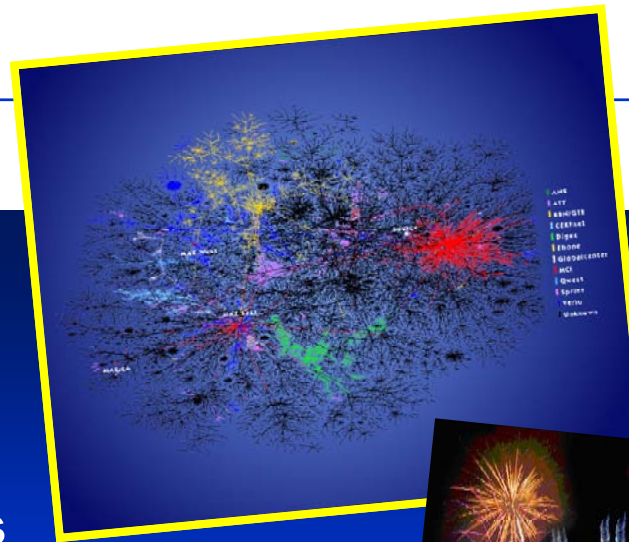
ICT drives...

- Productivity
- Economic Activity
- New Social Structures
- Creation of Frameworks for Progress

It's an Exciting World!

- Moving at an exponential pace
- Engineers are building the future

“You ain't seen nothing yet!”





Thank you!