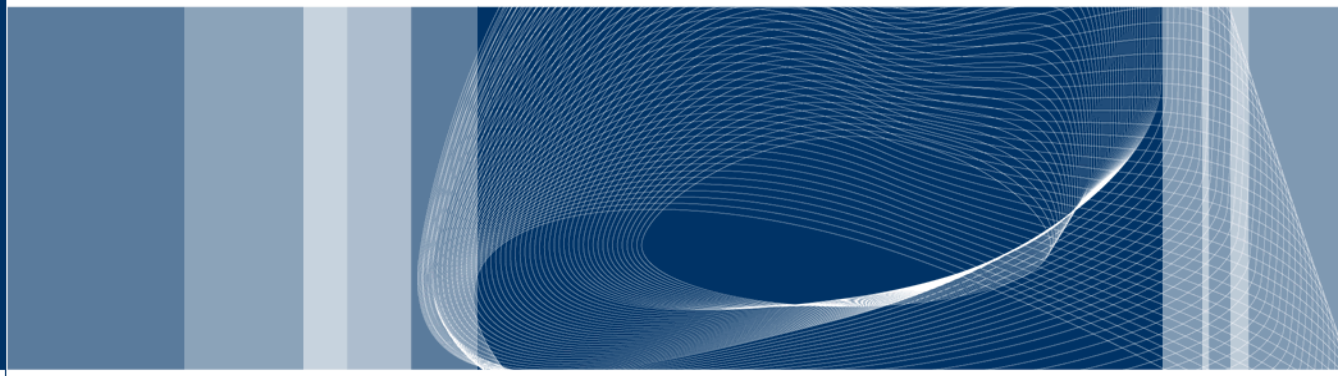
POLITECNICO DI MILANO



GETTING PRESCIENT KNOWLEDGE

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Prescient Knowledge

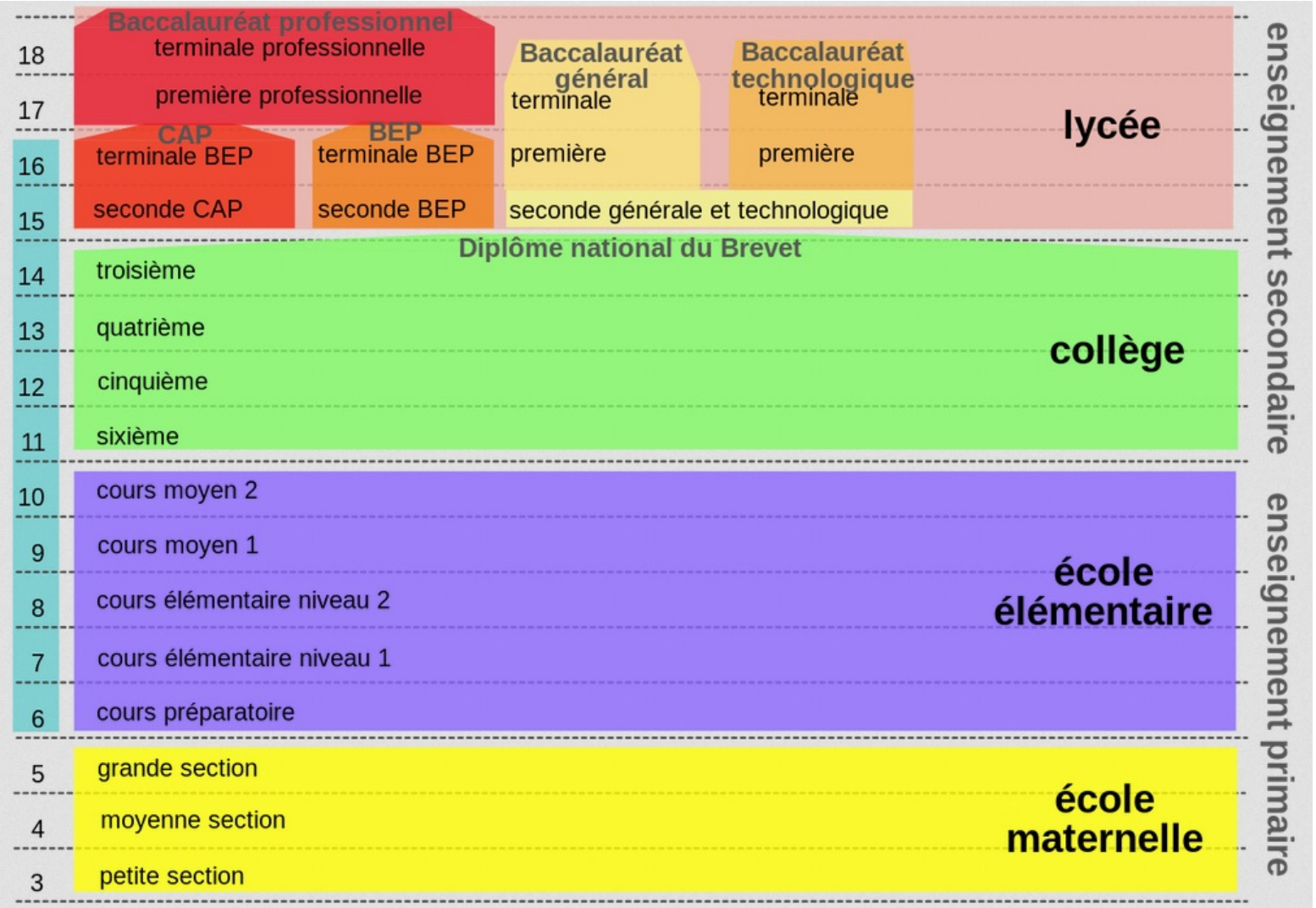
= Knowledge useful in the future

Knowledge

= the information + skills + understanding that you have gained through learning or experience

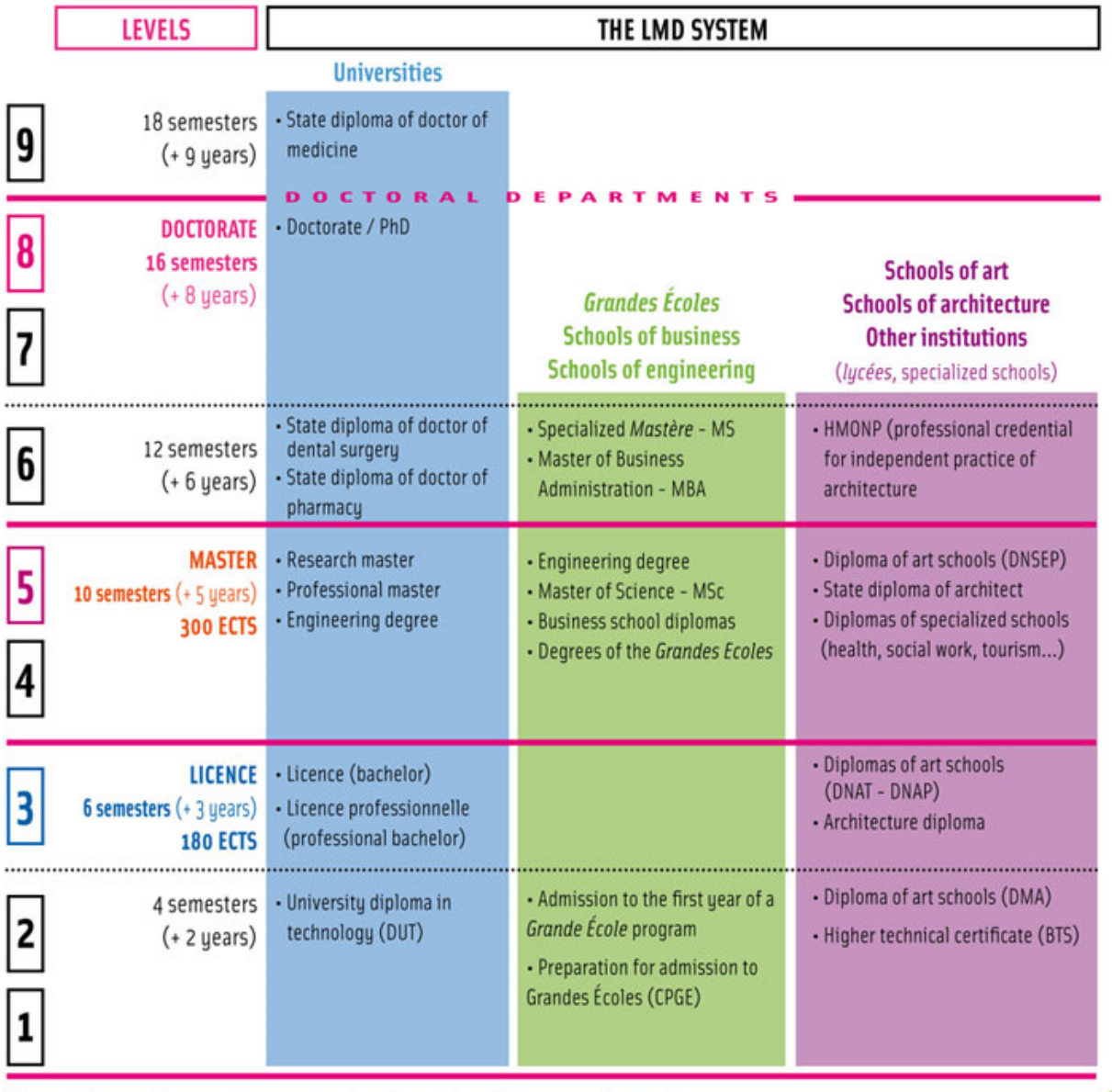
Sources: Longman dictionary of Contemporary English [http://www.ldoceonline.com/dictionary/knowledge] ;

French education system 1/2



Sources: http://en.wikipedia.org/wiki/Education_in_France ;

French education system 2/2



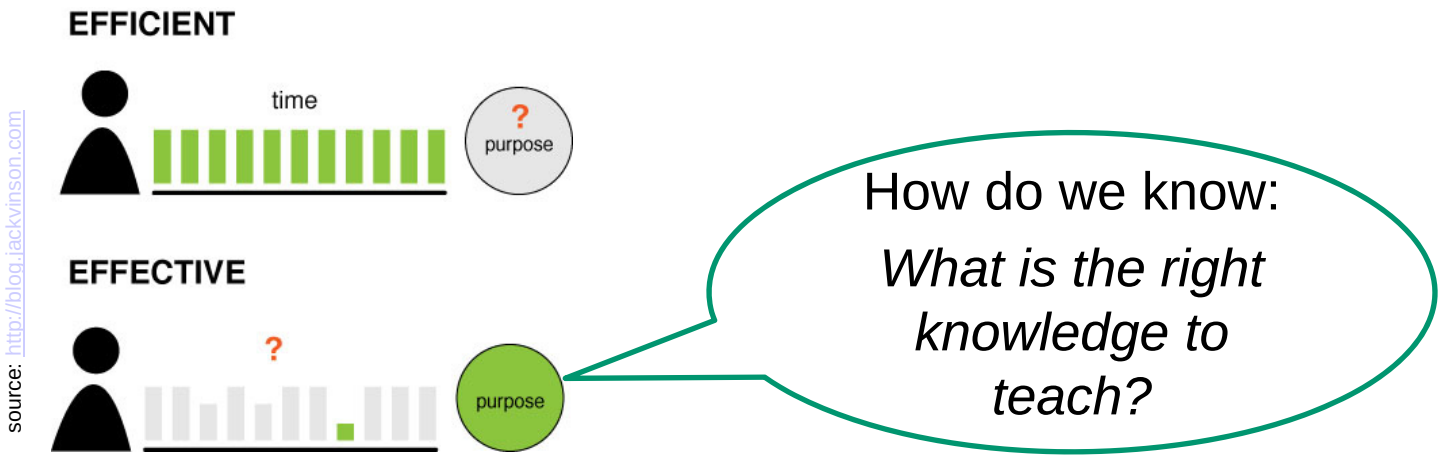
LEVELS		THE LMD SYSTEM		
		Universities		
9	18 semesters (+ 9 years)	• State diploma of doctor of medicine		
		DOCTORAL DEPARTMENTS		
8	DOCTORATE 16 semesters (+ 8 years)	• Doctorate / PhD		
7			*Grandes Écoles* Schools of business Schools of engineering	Schools of art Schools of architecture Other institutions (*lycées*, specialized schools)
6	12 semesters (+ 6 years)	• State diploma of doctor of dental surgery • State diploma of doctor of pharmacy	• Specialized *Mastère* - MS • Master of Business Administration - MBA	• HMONP (professional credential for independent practice of architecture
5	MASTER 10 semesters (+ 5 years) 300 ECTS	• Research master • Professional master • Engineering degree	• Engineering degree • Master of Science - MSc • Business school diplomas • Degrees of the *Grandes Ecoles*	• Diploma of art schools (DNSEP) • State diploma of architect • Diplomas of specialized schools (health, social work, tourism...)
4				
3	LICENCE 6 semesters (+ 3 years) 180 ECTS	• Licence (bachelor) • Licence professionnelle (professional bachelor)		• Diplomas of art schools (DNAT - DNAP) • Architecture diploma
2	4 semesters (+ 2 years)	• University diploma in technology (DUT)	• Admission to the first year of a *Grande École* program • Preparation for admission to Grandes Écoles (CPGE)	• Diploma of art schools (DMA) • Higher technical certificate (BTS)
1				

Sources: www.usa.campusfrance.org ;

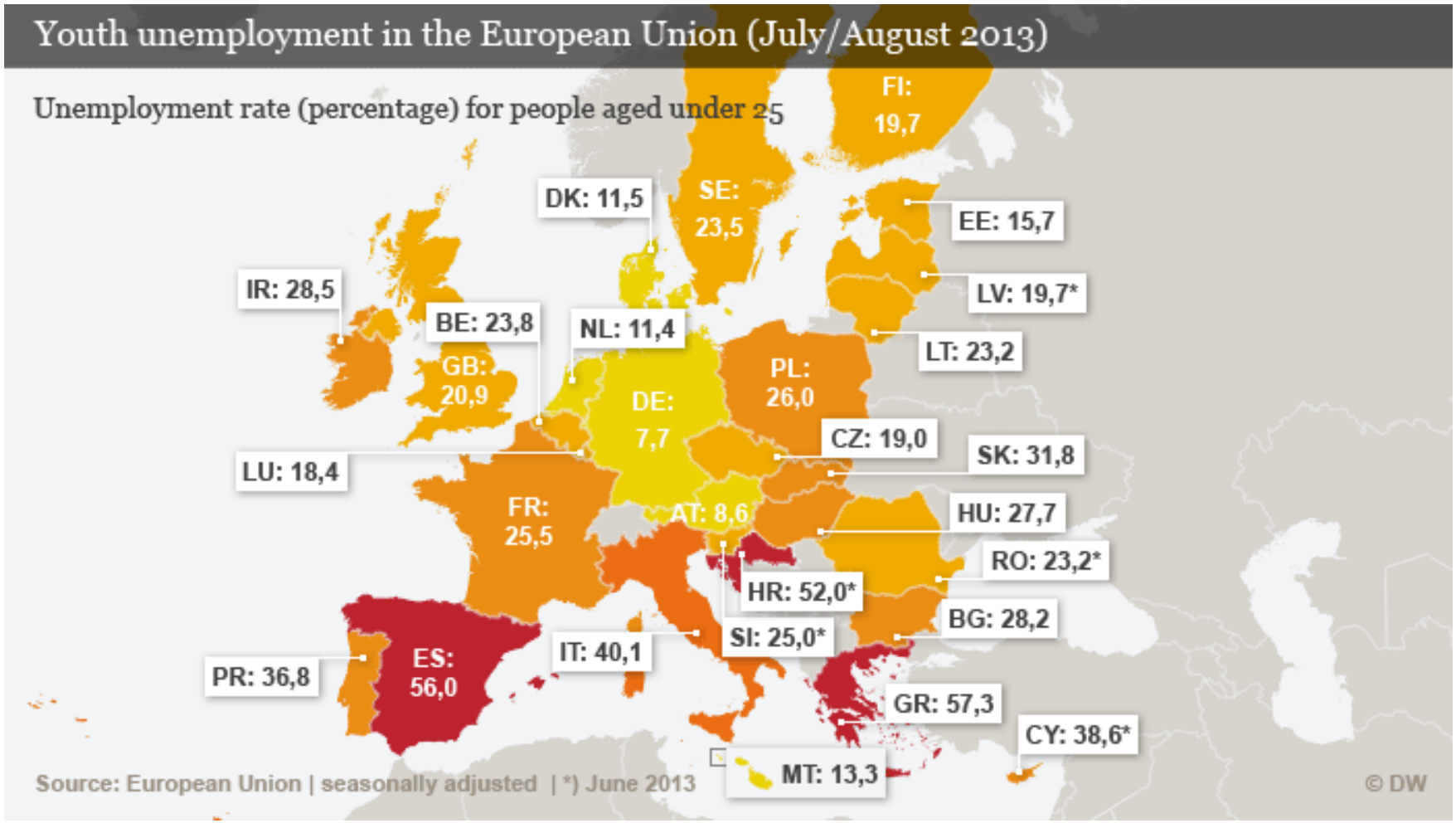
Efficiency is doing things right;

effectiveness is doing the right things…

– Peter Drucker



youth unemployment



…The righter we do the wrong thing,
the wronger we become…
– Russel Ackoff

Is it feasible to design educational programs without knowing what will be societal needs in 20 years?

available **Information**

+

today **Knowledge** ⇒ **Interpretation**

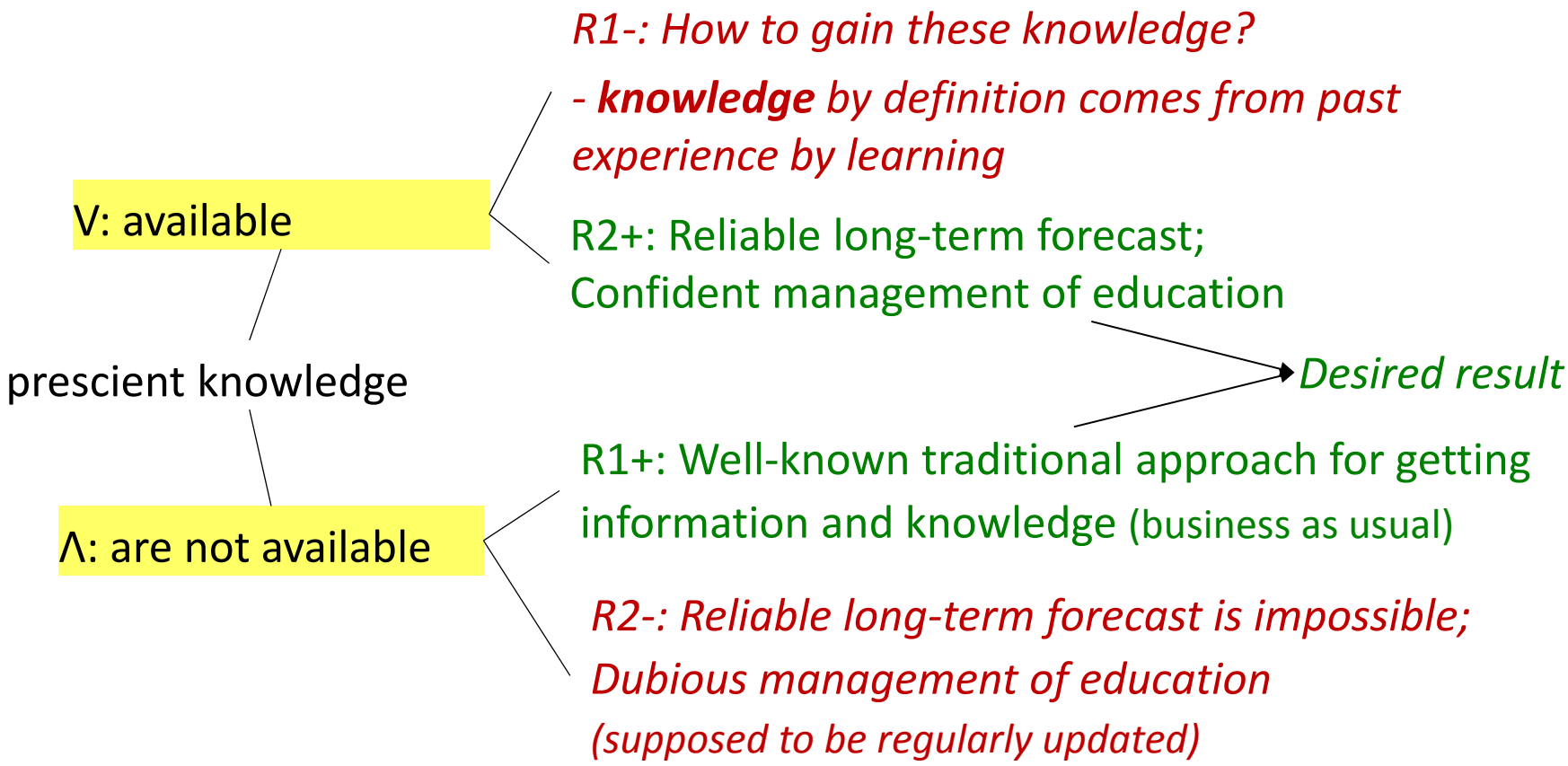
+

Intuition (biased?)

=

Decisions about education programs

Is it difficult for getting prescient knowledge?



what is suggested

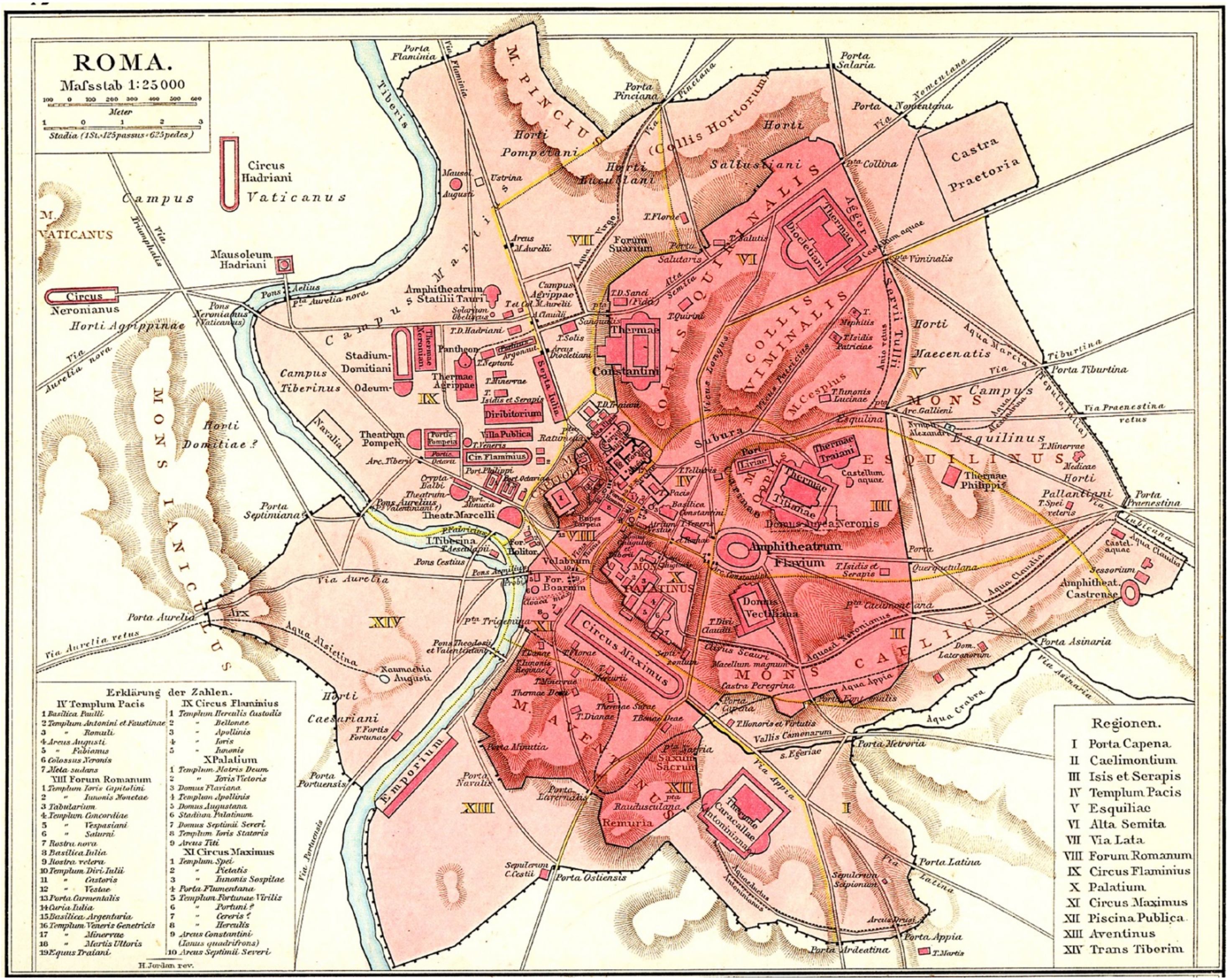
Problems are more important than solutions.

Solutions can become obsolete when

Problems remain.

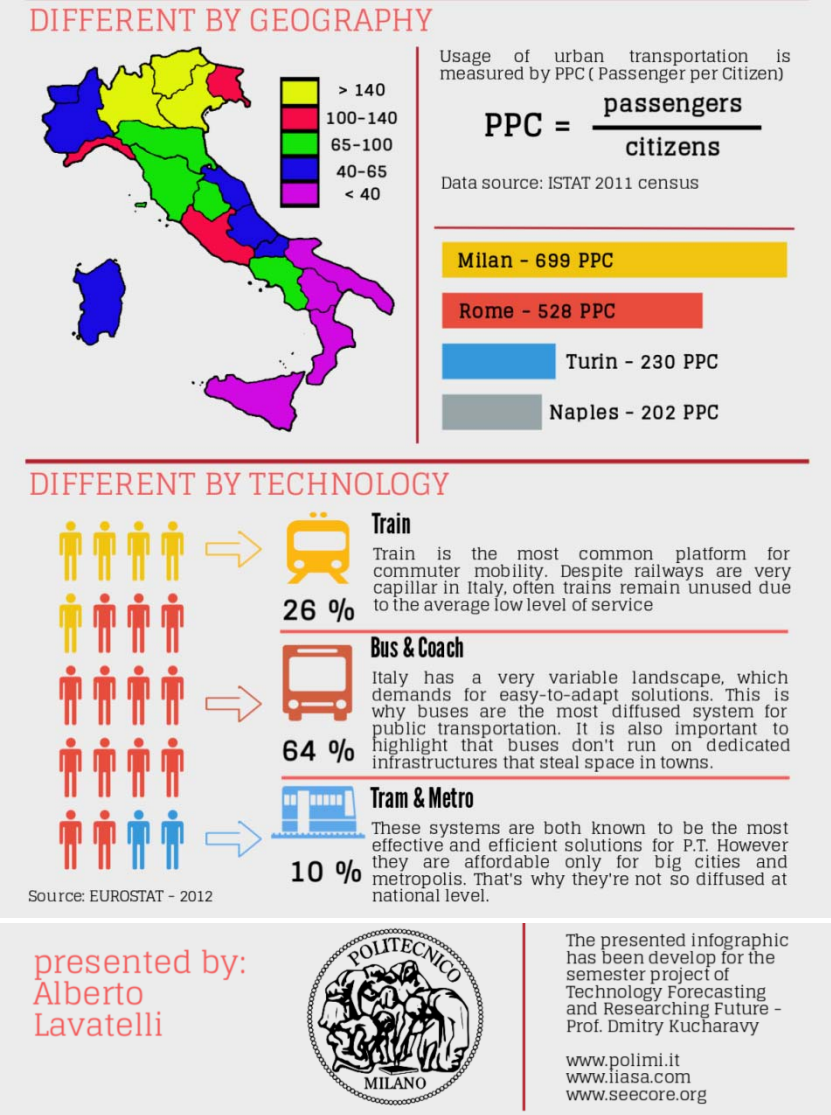
– attributed to Niels Bohr

map depicting late ancient Rome



Sources: http://en.wikipedia.org/wiki/Rome

to know about the present:
public transportation in Italian cities

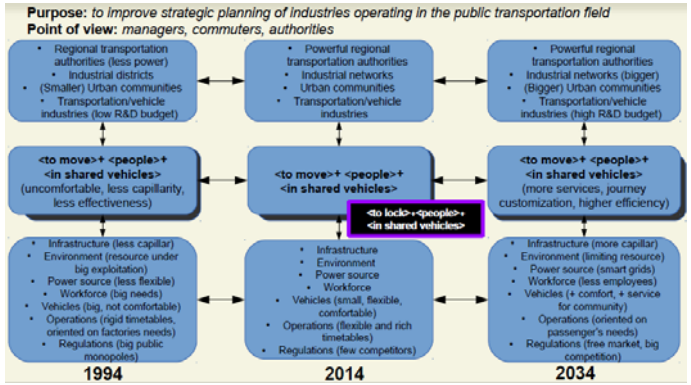


Source: Alberto Lavatelli (2014) Forecasting Italian urban public transportation: 2015-2035

collect & capitalize problems

Economics

Social



Technological

Environmental

Economical context		Technological context	
Drivers	Barriers	Drivers	Barriers
• *To bring workers to their job in a shorter time* • *To move people with less costs* • *Minimize workforce to run public services*	• *Long time to return from investments* • *High costs in upgrading public transportation systems* • *Cost of technological development* • *Cost of new infrastructures*	• *Higher efficiency in energy transformation* • *Safety enhancement* • *More capillarity* • *Lightweight structures* • *More efficient operations (new "orgware")*	• *Difficult to manifacture* • *Need to remove old solutions (decommisioning problems)* • *Reliability of new technologies* • *Old/new "orgware" transition is critical*
Sociological context		**Environmental context**	
Drivers	Barriers	Drivers	Barriers
• *P.T. improves life quality in big cities* • *Benefit for community (less pollution)* • *Benefit for one's self (good service = no need of personal vehicles)*	• *Workforce reduction (for public services)* • *Infrastructural NIMBY sindromes* • *"Old habits die hard": society's inertia throughout change*	• *Reduce air pollution* • *Save resources for future generations* • *Reducing energy consumption* • *Reducing the use of private vehicles = reducing traffic jam pollution*	• *Substituting or improving old technologies require energy* • *New infrastructures means consumption of new lands* • *Not every solution is suitable for a specific landscape*

1)How to increase payload of P.T. systems?
2)How to make investments in new infrastructures sustainable?
3)How to persuade people to build new infrastructure in their neighborhoods?
4)How to preserve the environment for human needs?
5)How to build more capillar P.T.?
6)How to plan the operations in order to follow the passenger's needs?
7)How to increase the flexibility of power supply?
8)How to reduce the need of workforce for P.T.?
9)How to regulate the market in order to make P.T. services more economical?
10)How to find a P.T. that is suitable for a complex landscape?
11)How to bring workers to factories in a faster way?
13)How is it possible for regional authorities to gain more power?
14)How is it possible for society to benefit from P.T.?
15)How can industrial districts grow bigger?
16)How can urban communities grow bigger?
17)How to increase R&D budget?
18)How to make P.T. systems more customizable?
19)How to change orgware without problems?
20)How to reduce traffic jam and the need for private vehicles?
21)How to avoid decomissioning problems?
22)How to increase number of stops without speed reduction?

Source: Alberto Lavatelli (2014) Forecasting Italian urban public transportation: 2015-2035

describe problems using contradiction model

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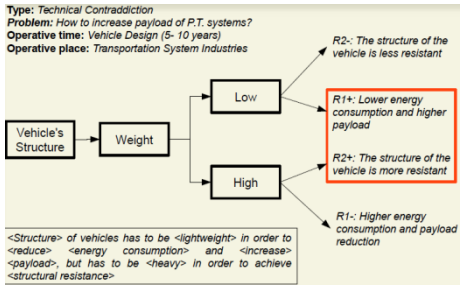

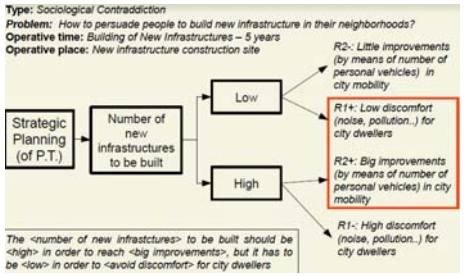

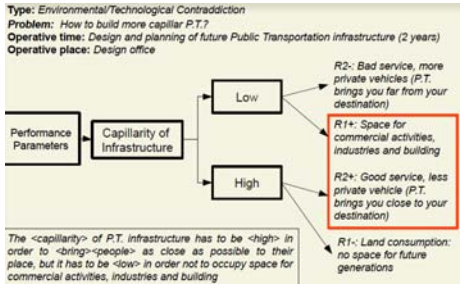

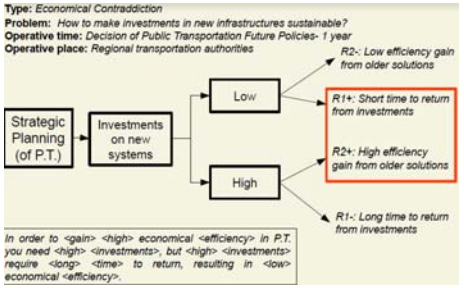

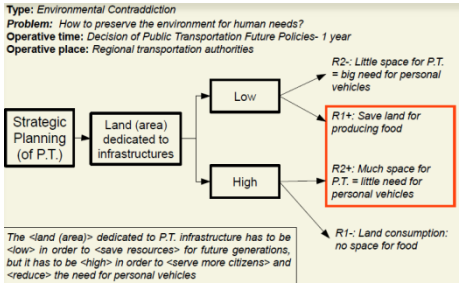

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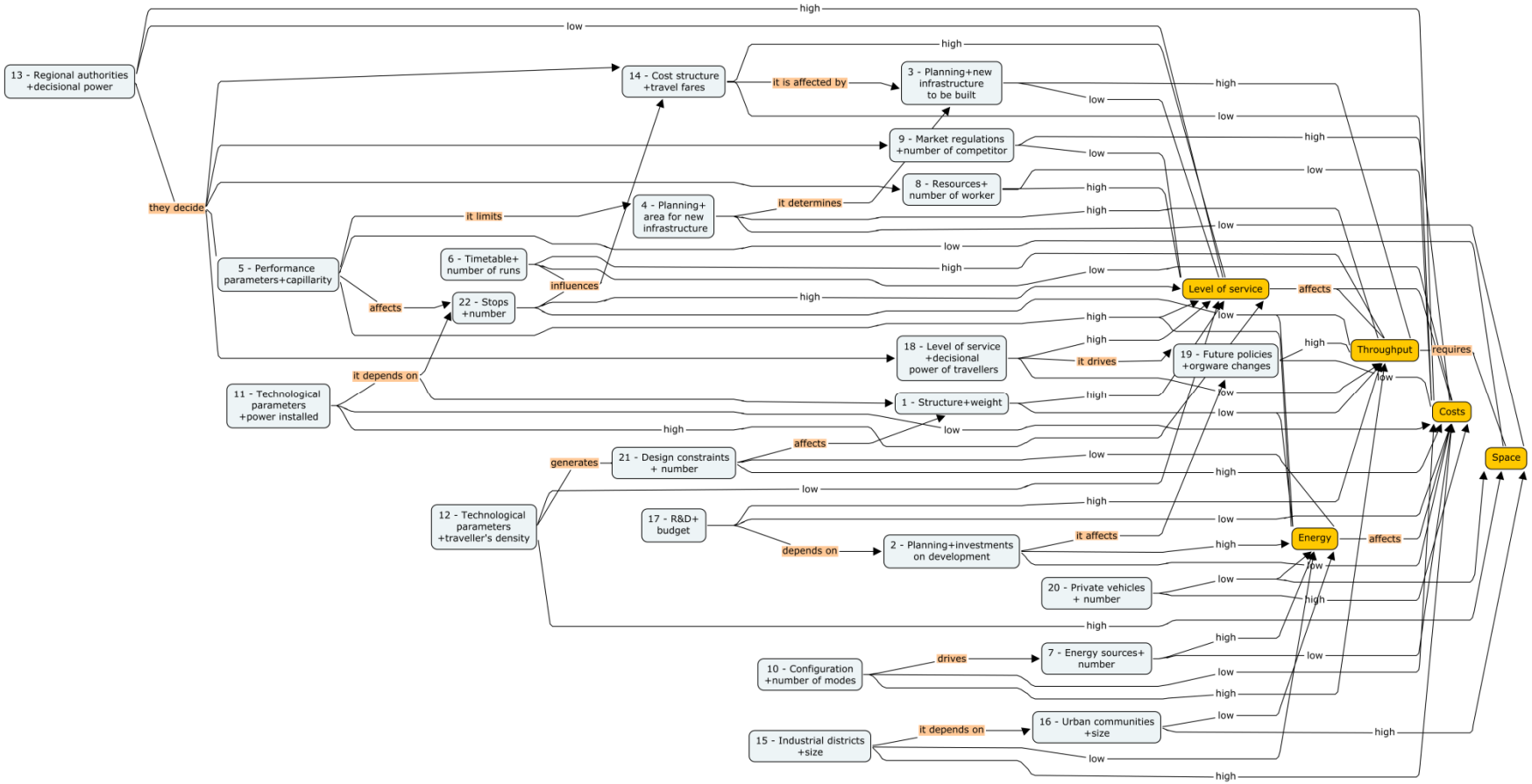
Source: Alberto Lavatelli (2014) Forecasting Italian urban public transportation: 2015-2035

to build a map of contradiction



Source: Alberto Lavatelli (2014) Forecasting Italian urban public transportation: 2015-2035

to use network of contradictions for getting prescient knowledge

1. to identify and measure critical-to-X features of future systems
2. to identify most important problems to be addressed in the first place
3. to localize existing solutions according to problems
4. to monitor evolution of system in time
5. to support strategic decisions and plannings
6. ???

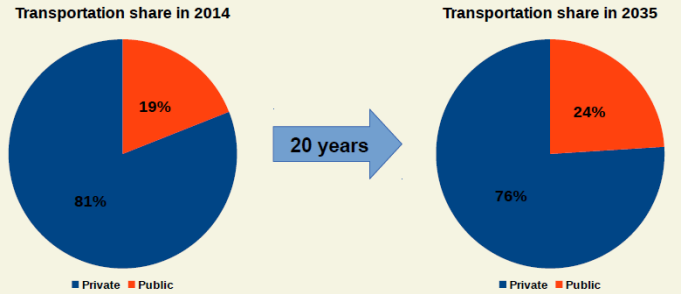
critical-to-X features of future systems and future systems

Critical feature	Units	How in the 2035?
Costs	$\frac{passenger \cdot km}{€}$	In the future we will have more pkm, while it is expected that costs (€) will be slightly reduced.
Energy	$\frac{passenger \cdot km}{kWh}$	In order to comply to the limiting resources (mostly pollution), in the future we will spend less energy for increased pkm.
Space	$\frac{passenger \cdot km}{m^2}$	In 2035 it is expected that area occupied by P.T. systems will not vary, however the output (pkm) will grow.
Throughput	$\frac{passenger}{h}$	In the future passengers will travel for less time thanks to the increased speed of transportation. As a result, throughput will be increased.
Level of service	$1-\frac{delay\ time}{total\ time}$	It is expected that in future the percentage of delays will decline, thanks to relevant orgware changes. As a consequence the indicator tends to 1

To sum up 2035 technologies

	Small cities (<200k)	Medium cities (200k-900k)	Big Cities (>900k)
Metro	-	-	Network in expansion in Milan. Minor expansion in Rome and Turin. Increase passenger widely. It will become skeleton for other systems.
Train	-	Cities interlinked by industrial network will see a substantial growth of train passengers for local transport	Train will integrate with metro in multi-modal way, in order to reach city centre by underground. Increase in passenger and average speed
Tram	Will appear in Northern Italy as multi-modal. Under 10% threshold	Will appear in Northern Italy as inter-modal. Under 10% threshold	Tram will integrate with busses, but there won't be space for new infrastructure. Old ones repowered
Bus	Leading system, growth in passenger and technological evolution	Leading system, growth in passenger and network. Technological evolution	Bus in big cities will have always more dedicated roads, due to traffic policies. More passengers
Bike Sharing	Implemented, but won't reach 10% threshold	Widely implemented, but won't reach 10% threshold	Big usage, but still won't reach 10% threshold
Car Sharing	-	-	Big development at orgware level. It will reach 10% threshold by 2030

public transportation usage in 2035



The present situation sees the bus as the **leading technology** of public transportation. As a consequence, it is necessary to monitor the growth of the system since it represents a **major part of the market** for many Italian transportation industries.

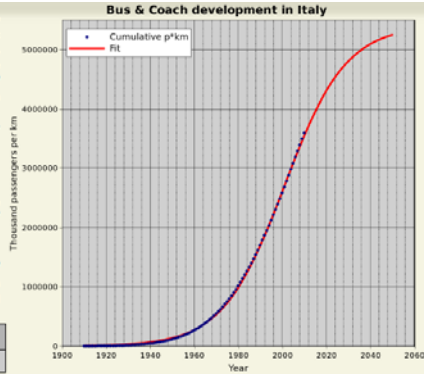
This technology is still in a phase of growth, so it will be a leading one in 2035.

However the questions are:

- **Does it grow in passenger or in km?**
- Will it be necessary to boost the range of vehicles or to enhance the capacity of the vehicles?

According to the urban population forecast, it is expected that the **number of passengers is going to grow**. As a consequence, investments will be focused on growing throughput performances

N°	Phenomenon	K	T_m	dT
1	Output growth	5408000	2001	62



The next (2035) system

New system traits	Sub-features
Use existing infrastructures and technologies	*Exploit space/volume more efficiently*
	Automatic or semi-automatic guidance
	At least 10% increase in average speed
Intermodal, multi modal	*Vehicle able to run on road & railways*
	Vehicle able to automatically manage their speed/stops in order to synchronize with connecting schedules
Optimized design	*30% less weight (reach structural efficiency of aircrafts)*
	20% less energy dissipation (improved aerodynamics, contact drag, energetic efficiency of engines).
	Optimize concentration of passenger in a single unit of vehicle with space/comfort of passengers
Use flexible power systems	*Smart grid compliance*
	Dual motor equipment: one dedicated to low speed- high acceleration, the other to high speed- low acceleration
Wider offer of services	*Full broadband connection to the internet*
	On the go shops: buy things during the journey, retire things on the arrival station
	On the go offices: possibility to run everyday bureaucracy while travelling

Source: Alberto Lavatelli (2014) Forecasting Italian urban public transportation: 2015-2035

validation

- 2004–2005: Project - Technological forecasting of **Fuel Cells for small stationary applications**, EIFER, Karlsruhe, Germany;
- 2005-2006: Project - Technological forecast of **Distributed Generation** (DG), EIFER, Karlsruhe, Germany;
- 2005-2009: 9 publications and 3 research reports about methodology of technological forecasting;
- 2008, June 26-29: **4 days seminar**: *Technological Forecasting*: prediction of technology change. Apeiron, at Vinci, Italy;
- 2010, December: **3 days seminar**: *Forecasting the Problems*, Arçelik, at Istanbul, Turkey;
- 2011-2012 : Project - Forecasting the parameters of the technological dynamics of **a technological core area of Chilean mining industry**, CBC, Santiago, Chile;
- 2013- : European R&D Project: FORMAT (**FOrecast and Roadmapping for MAnufacturing Technologies**)
- 2014 - : **64 h course** (6 credits): *Technology Forecasting and Researching Future*. at Politecnico di Milano, Italy

what is suggested

up to date **Data**

+

Knowledge about problems

$\Rightarrow$ consensus **Interpretation**

+

conscious **Intuition**

=

problem-based **Decisions**

POLITECNICO DI MILANO

FORMAT
Forecast and Roadmapping for Manufacturing Technologies

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