DLT - Panama & Colombia

The Digital Transformation

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The Digital Transformation

- Digital Transformation
- Digital Twins
- Digital Infrastructures
- Digital Cities
- Digital Healthcare
Digital Transformation - In a Nutshell …

❖ DT is here, now
❖ … but what is it?
❖ … bits, the new gold?
❖ … everywhere?
What is it?

❖ Shift to the Economy of Abundance
❖ A shift from Atoms to Bits
❖ Affecting
  - Products
  - Processes
  - Biz Models
What is it?

❖ Leveraging on bits
- Monitor
- Analyses
- Simulation
- Influence
What is it?

❖ It co-exists with the Economy of Scarcity
Offer vs Demand
Scarcity is Gold!
Abundance is commodity!
The Market Value decreases
... bits, the new Gold?

Green: Digital Content

Red: Analogue Content

Stanford study 2010
... bits, the new Gold?

❖ It affects all biz
❖ It is a structural change
❖ 2G > 3G > 4G
❖ >> 5G
… bits, the new Gold?

❖ Where does the value go?
- consumers save > spend on something else
- Low transaction cost > empowers small players
Everywhere?

- Different penetration
  - by sector
  - by geography
Everywhere?

- Micro shift vs Macro shift
- Take the broader view
Everywhere?

- From Micro to Macro
- Can I whistle?
- OTT
 Everywhere?

- It has just begun
  - can be opposed
  - can be fostered
- It will happen
- Disruptions
Take Away

- Technology is an enabler
- Market and competition are the drivers
- Regulations can slow the speed of change
- Revenues shift and decrease, freeing resources
Fuelling the D.T. - In a Nutshell

- Increased efficiency
- ... lesser cost
- ... lower entrance barrier
- ... tiny revenues
- ... ecosystems growth
Lesser Cost

- Bits have low:
  - duplication cost
  - transportation cost
  - manipulation cost
  - storage cost
Lesser Cost

- Zero cost enables new processes e.g. Industry 4.0
- Zero cost enables new biz models e.g. Indirect revenues
- Zero cost stimulates the culture of “free”

Lesser Cost

- Lower cost drives Industry adoption
- Focus is on internal efficiency gain

Lower Entrance Barrier

- Only true for the “bits” part …
- It requires supporting infrastructures
- Infrastructures may lead to lock-in
Lower Entrance Barrier

- Lower Entrance Barrier drives PA adoption
- PA is ideally positioned to foster infrastructures
Lower Entrance Barrier

❖ Apps stores*
  - Google: 2.47M apps
  - Apple: 1.8M apps

❖ Worldwide market

❖ 88B$ revenues in 2016
  189B$ rev. 2020 forecast

* as of 3rd quarter 2019 -
Lower Entrance Barrier

- Big Players are threatened
- Iliad
  - quick uptake
  - market destruction
Tiny Revenues

- Banana
- TlcARPU: <10€
- Apps
  average revenue: 20,000€
Ecosystem Growth

❖ Ecosystem Creation
- seeding
- attracting
- supporting

❖ Ecosystem type
- ambient based
- platform centered
- product centered

Ecosystem Growth

- Viral growth
- Self fueling

Drone Ecosystem Map 2018

Take Away

❖ Lower cost drive adoption
❖ Lower entrance barrier increase players
❖ Platforms are needed and they are expensive
❖ Oligopolies on platform - lock in
❖ PA is ideally positioned to create platforms
❖ Platforms fuel ecosystems
What is a Digital Twin?
Extending the Digital Twin
Application in Healthcare
What is a Digital Twin?

❖ A mirror of a real entity
  - a product
  - a component
  - a process
  - a data set

❖ It can be used
  - to simulate
  - to enact
  - as a proxy

Image credit: General Electric
What is a Digital Twin?

❖ From an object simulation to an operational replica of the object life cycle in the digital space

❖ Expanding to achieve a life of its own that needs to be kept in synch with the physical twin

❖ Co-existing and part of the features set of the physical twin, connected via AR
What is a Digital Twin?

❖ Digital Model
❖ Digital Shadow
❖ Digital Thread
❖ Digital Twin

Image credit: Automotive Design and Production
What is a Digital Twin?

Digital Twin used in:

❖ Design
❖ Maintenance
❖ Performace tuning
❖ Safety
❖ Customer Experience
Extending the Digital Twin

Covering the whole Life-Cycle

- design and co-design
- supply chain
- manufacturing
- service provisioning
- operation and maintenance
- building-up virtual component

Image credit: Siemens
Extending the Digital Twin

Virtual Digital Twin

- Created from data, not from objects:
  - the Digital Twin of a city
  - the Digital Twin of a hospital
  - the Digital Twin of a Country Healthcare

Image credit: Singapore Gov.
Digital Twin in Healthcare

Human Digital Twin

- Mirroring a specific subset dependent on the application
- Physical mirroring
- Behavioural mirroring
- Cognitive mirroring

Image credit: Aware
Digital Twin in Healthcare

- Hospital planning and Mgt
- Patient care (real modeling starting in the next decade)
- Massively-collaborative data-driven and scenario based decision making
- Short term forecast
- Process improvement
- From requirements to system dynamics through simulation

“I believe we will end up with health care being the ultimate digital twin.”

Bill Ruh
CEO, GE Digital

Image credit: GE
Take Away

❖ Digital Twins are here to stay

❖ Industry is rapidly adopting them and in doing so it is reshaping its internal processes and the whole Value Chain

❖ Digital Twins stem from existing digital assets but require the rethinking of the whole processes in the Value Chain

❖ When seen as flanking the whole Value Chain they become an active force in fostering the Digital Transformation
Digital Infrastructure - In a Nutshell …

- Digital Infrastructures
- Transport Layer
- Network as a Service
- Data Centre Network
- Knowledge Infrastructure
- Devices
Digital Infrastructures

- Physical and logical resources to support access, visualization, transport, storage and processing of bits.
Digital Infrastructures

- Physical and logical resources to support access, visualization, transport, storage and processing of bits
- Bits are conceptually, here, there and everywhere. It is an architectural choice. The architecture is influenced by technology, economics and regulatory consideration

AWS Data Centres. Source: linux
Digital Infrastructures

- Physical and logical resources to support access, visualization, transport, storage and processing of bits
- Bits are conceptually, here, there and everywhere. It is an architectural choice. The architecture is influenced by technology, economics and regulatory consideration
- New technologies foster new architectures and availability of new types of resources

NFV - SDN shift the network to the Cloud. Credit: CableLabs
Transport Layer

- Wired
  - fiber in the core
  - fiber at the edges
  - fiber to the X

Source: Allied Telesis
Transport Layer

- Wired
- Wireless 3/4/5 G
  - fiber to the tower
  - AAS (Advanced Antenna Systems - beamforming / MIMO
  - Cloud at the edge
  - Network Slicing
  - Session Control

Source: RF Wireless World
Transport Layer

- Wired
- Wireless 3/4/5 G
- Wireless - other systems
  > WiFi (6)
  > LiFi

11AX
THE PATH TO TRULY BRILLIANT WI-FI

Source: Intel

ComSoc
IEEE Communications Society

COMS
IEEE Communications Society

FUTURE DIRECTIONS
IEEE FUTURE DIRECTIONS

Better in dense environments
Improve average throughput per user by at least four times in dense or congested environments

Faster throughput
Deliver up to 40 percent higher peak data rates for a single client device

Increase network efficiency
By more than four times

Extend battery life
Of client devices
Transport Layer

- Wired
- Wireless 3/4/5 G
- Wireless - other systems
- Networks at the edge
- > Mesh Networks

Source: Veniam
Network as a Service

- 5G supports/leverages Network Slicing
  > the service requests the desired network functionalities

- Flexible data architectures
  Data centres can be distributed: service providers, network clouds, devices

Figure 2. ZTE’s 5G network architecture. Source: ZTE
Data Centre Network

❖ Heavy traffic inside the DC
  > three-tier structure
    - access layer (connecting serv)
    - aggregation layer (firewall, authentication, local traffic)
    - core layer (in/out traffic)
❖ Scale is everything
❖ Power hungry (AC and servers)
❖ Distributed Data Centers

Figure 5: Global Data Center Traffic by Destination in 2020

Source: NACTO
Future Networks will have an autonomous behaviour

> aware of their computational and environmental context

> this is based on a knowledge network that covers

- applications
- services
- users
- social knowledge
Devices

- Smartphones are ubiquitous, can be used as
  - sensors
  - massively distributed repositories
  - processing points
- Wearable in the next decade will take up.
  Seamless by decade end
- Devices shall be considered as networks at the edges and data centres at the edges
- Take devices into account when designing your network infrastructure

Source: Consumer Experience Design
Take Away

- Wired (fiber) networks are essential ... to support wireless
- Variety of wireless technologies and architectures
  5G can be the unifying architecture but it is not happening soon (bet for 2025).
  WiFi 6 will dominate inside
- As networks increase their capacity, they also become commodities.
  Network as a service is something to consider for your business
- Devices lead (the tail wags the dog)
Digital Cities - In a Nutshell …

- Cities as Infrastructures
- Every city is smart, and can get smarter
- Enabling Technologies
- Smarter Cities
- Singapore’s Digital Twin
The Value of Infrastructures

Kleber’s Law

• Metabolic Rate = 70M^{0.75}

• Surface vs Volume

• Ought to be M^{0.66}

• Fractal Infrastructure

• The infrastructure is **key** to increase volume
Cities as Infrastructures

Kleber’s Law

- The bigger the city, the greater the wealth produced per capita. Why?
  - Wealth attracts people or more people create more wealth?
  - Wealth = $a \cdot \text{Pop}^{0.75}$
Cities as Infrastructures

**Kleber’s Law**

- Can we design infrastructures with higher efficiency than the fractal ones?
- ICT infrastructures can deliver higher efficiency
- The Digital Transformation is about higher efficiency
Every City is smart & can get smarter

- Cities as ecosystems in dynamic equilibrium
- Infrastructures are keeping the ecosystem together and are a factor in the wellbeing of citizens
- Physical infrastructures do not scale gracefully, soft infrastructures scale easier
- Either a city gets smarter or it gets worse
Enabling Technologies

**Sensors**

- IoT - working as sensors and actuators
  - Acoustic
  - Electtr/Magn / Optical
  - Chemical
  - Mechanical
  - Thermal
  - Spatial

IoT feeding data and acted upon. Image credit: Province of Trento
Enabling Technologies

**Sensors**
- IoT - working as sensors and actuators
  - Acoustic
  - Electtr/Magn / Optical
  - Chemical
  - Mechanical
  - Thermal
  - Spatial
- A medium size city can generate a PB a day, most of these data are lost
- Data understanding is crucial
- Data are the fabric to dress up the smart city

**Smart City Solutions Will Inundate Governments And Partners With Data**
Annual data generated by global smart city solutions, billions of terabytes

![Bar chart showing annual data generation from 2016 to 2024](chart.png)

Source: Business Insider Intelligence estimates, 2019; Cisco, 2018
Enabling Technologies

Communications Infrastructures

❖ Pervasive optical Infrastructure
❖ Wireless drops
- Operators’ wireless infr. > 4/5G
- Private wireless gateways > WiFi 5/6
- Visible Light Comm > LiFi
❖ Point to point wireless > Bluetooth, Zigbee
❖ Mesh networks
❖ Pirate networks
Enabling Technologies

Data Platform

- Open Data
- Multiple streams
- Creative Commons
- Managing:
  - privacy
  - ownership
  - accountability
  - trust
- API service oriented based retrieval

Trentino Open Data Platform. Image credit: Province of Trento
Enabling Technologies

- Encapsulated entities
- Signals generation
- Context Aware
- Able to learn
Enabling Technologies

FIWARE

- A Platform for Smart Cities
- Aggregates data from IoT, fostering applications reuse
- Engineering, Atos, Telefonica, ...
- FIWare Foundation
Enabling Technologies

**Smartphones**

- Smart Phones are:
  - Sensors
  - Data storage
  - Processing units
  - Customisers
  - Access points
  - Citizens’ preferred Interface

- Central monitoring vs app based sensing (opt in)

- Privacy issues to be managed
Smarter Cities

Sharing Economy

❖ Cities can foster the sharing economy:
- sharing infrastructures
- sharing data
- sharing services
- PPP
- creating a culture

❖ Overcome the NIH syndrome
- promote reuse of services
- adopt standards
- open platforms

Collaborative Economy: Past, Present & Future of Auto Industry

Old: Everyone owns a car.
New: Zipcar owns a car; everyone walks to & rents what they need.
Newer: Some own a car; others walk to & rent what they need.
Newer New: Car comes to you when you need it.
Smarter Cities

- Increase citizens awareness:
  - speak their language
  - create culture
  - use social media

- Increase engagement
  - each one can make a difference
  - citizens as sensors and info sources

- Augmented Reality
Singapore’s Digital Twin

- 73 million $ over 5 years
- 3D semantic modeling of the whole island
- Supports:
  - virtual test-bedding
  - virtual experimentation
  - planning and decision-making
  - research and development
- Benefitting:
  - Government
  - citizens
  - business
  - research community
Singapore’s Digital Twin

- Uses of Virtual Singapore
  - Collaboration and Decision-Making
  - Communications and Visualization
  - Improved Accessibility
  - Urban Planning
  - Analyses potential for Solar energy production

- Singapore’s Digital Twin resulting from the interplay of several Digital Twins, including:
  - roads infrastructure
  - power infrastructure
  - waste management
  - buildings
  - public transportation
  - communications infrastructure
Singapore’s Digital Twin

Simulation of crowd movement based on Singapore Digital Twin. Clip credit: Prime Minister Office of Singapore
Take Away

❖ Cities are dynamic ecosystems, each participant influences all the others

❖ Technology evolution is a given. The problem is what and when should be deployed

❖ Data are plentiful, the issue is how to leverage them in a multi-party context, often with conflicting interests

❖ Smartphones are ideal tools for the smartification of a city

❖ Digital Twins can be stewarded towards a city Digital Twin
Digital Healthcare - In a Nutshell ...

- Healthcare Digital Transformation
- Enabling Technologies
- Digital Twins
- Flanking Physical-Virtual
- Paradigms shift
Healthcare Digital Transformation

- Digital transformation is already improving:
  - patient outcomes, disease prevention
  - patient experience, loyalty
  - care coordination across specialists
  - cost reduction
  - faster innovation in care teams

- Expected 30% gain between 2017-2020

- Led by smart medical devices / wearables, IoT, AI, cloud and data analytics

Effect of Digital Transformation on Healthcare in APAC. Image credit: Profit from IoT
Healthcare Digital Transformation

- Growing investment in eHealth
- Growing funding of start ups in the Digital Health
- Unsustainable cost increase in Healthcare
- Organisational barriers are slowing the progress
- 2018 estimate of Digital Transformation in Healthcare is around 20%
Enabling Technologies

❖ Diagnostics

- lower cost for tests
- higher sensitivity
- computer vision
- data analytics

❖ Expected evolution

- personalised testing
- at home diagnoses
- Digital Twin
- markers
- proactive testing based on data analytics
- Lab on a chip

Lab on chip (LOC) is device that integrates laboratory functions on nano chip.
Image Copyright: science photo / Shutterstock
Enabling Technologies

❖ Diagnostics

❖ Instrumentation

- robotic surgery
- virtual surgery
- micro probes / instruments
- embedded devices
- computer vision

❖ Expected evolution

- micro robots
- nanobots
- computer vision

Testing defibrillator on human model. Image credit: ANSys
Enabling Technologies

❖ Diagnostics

❖ Instrumentation

❖ Monitoring
  - Ambient devices
  - on body devices
  - contact devices
  - embedded devices
  - data analytics

❖ Expected evolution
  - personal monitoring
  - drugs associated monitoring

Assessing heart attack probability in real time. Image credit: MRC MLS
Enabling Technologies

❖ Diagnostics
❖ Instrumentation
❖ Monitoring
❖ **Wearables**
  - smart watches
  - smart clothes
  - smart bands
❖ Expected evolution
  - smart contact lenses
  - electronic tattoos

Diabetes Analyzing Contact Lens. Image credit: Business Korea
Enabling Technologies

- Diagnostics
- Instrumentation
- Monitoring
- Wearables
- Genomics
  - proactive healthcare
  - personalised healthcare
  - in body drugs manufacturing
  - virus/bacteria resistance
  - data analytics

Impact all healthcare. Image credit: MINC
Digital Healthcare Tech Impact

- Wearable Sensors
- Digital Imaging
- Virtual / Augmented Reality
- Data Analytics
- Artificial Intelligence
- Chatbots
  - personalised always on support
  - Digital Twins
Digital Twins

Resources
- Modeling static resources
- Modeling processes
- Modeling aggregation
- Mirroring patients (long terms)

Services

Patients
Flanking Physical-Virtual

- Virtual Surgery - haptic
- Collaborative diagnoses and cure
- Augmented reality AI assisted
- Clinical trials - data analytics
- Patient training
- Virtual doctor

Preparing for brain surgery using VR Image credit: UCLA
Paradigm shift: Personalised Healthcare

❖ Each person is unique
  - genome
  - environment
  - habits

❖ would love personalised care
  - lack of resources
  - lack of time!
  - cost

❖ Digital Twins in Healthcare
  - Institutions role
  - Regulatory framework
  - Opt-in
Paradigm shift: Community Healthcare

❖ Processes & resources
- map the landscape
- where to start?

❖ Begin with the basics
- EHR
- European Recommendation

❖ Exploit the data
- Community value/services
- Data analytics
- Health maps

Source: Healh Catalyst
Paradigm shift: Proactive Healthcare

- A paradigm change
  - persons take responsibility > create awareness
  - cultural change

- Decrease cost and improve wellbeing
  - shift cost to proactive treatment involving the person
  - adopt a service oriented mindset

- Stimulate Economy
  - tremendous potential for innovation
  - foster open data and service creation
Take Away

- Healthcare is a growing cost, digitalisation as a tool
- Technology is fostering the transformation
- Healthcare as personalised services
- Need to create awareness and participation
- Need to balance privacy with societal benefits
- New ethical questions arising
Symbiotic Autonomous Systems

Image credit: FDC
Converging Trends

Image credit: FDC
DLT - Panama & Colombia

The Digital Transformation

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blog: https://cmte.ieee.org/futuredirections/category/blog/