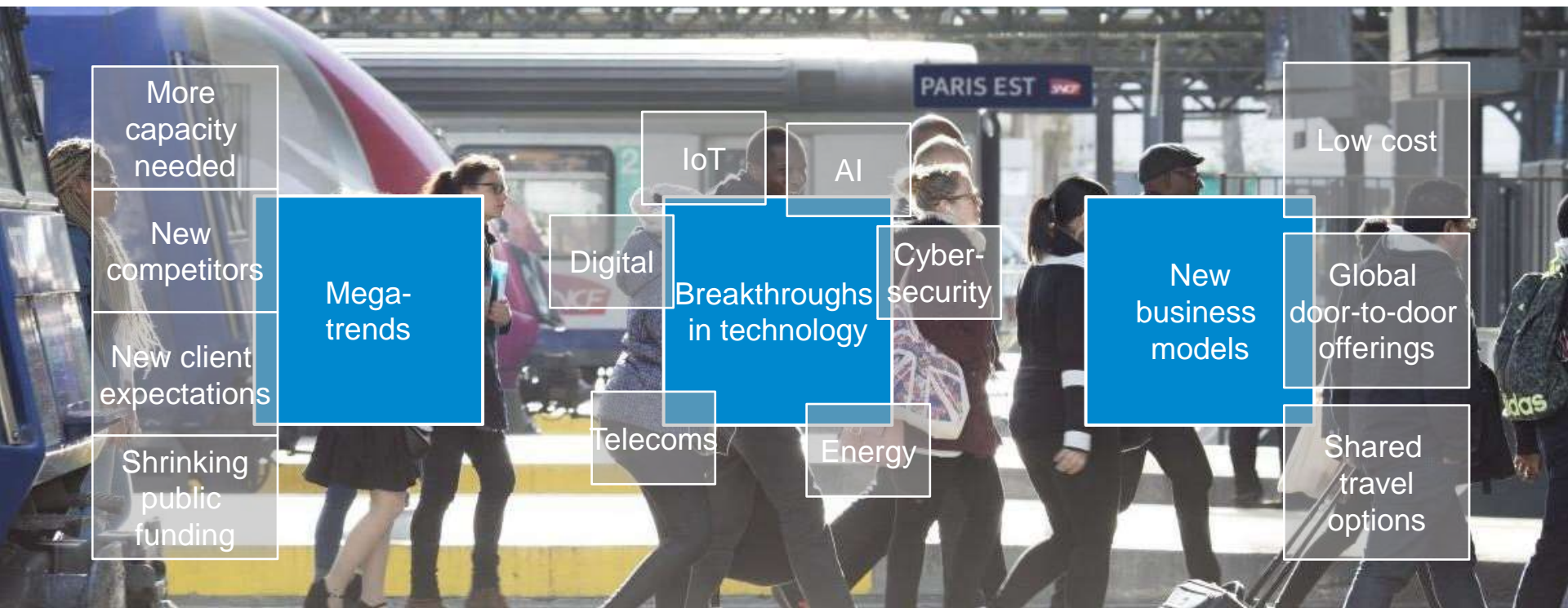# THE RAILWAY SYSTEM OF THE FUTURE—OUR VISION

THE RAILWAY SYSTEM MUST REINVENT ITSELF TO COPE WITH COMING UPHEAVALS IN MOBILITY

More capacity needed

New competitors

New client expectations

Shrinking public funding

Mega-trends

IoT

AI

Digital

Cyber-security

Breakthroughs in technology

Telecoms

Energy

New business models

Low cost

Global door-to-door offerings

Shared travel options

TECH4RAIL

SNCF

INSPIRED BY STUNNING NEW DEVELOPMENTS IN MOBILITY…

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WE'RE RETHINKING RAIL THROUGH INNOVATION:
MEET SNCF'S TECH4RAIL PROGRAMME

ROLL OUT NEW TECHNOLOGIES	MOVE FASTER	CREATE VALUE	DARE TO REINVENT OURSELVES
• Harness breakthroughs in emerging technologies	• Secure new technologies through partnerships with other industries, academics, IRTs and start-ups	• Give SNCF's operational performance a significant boost • Position SNCF as a pace-setter in rail systems and mobility • Break free of the past to consider new businesses	• Get our engineers on board: motivate and stimulate • Use technology to surprise

TECH4RAIL SNCF

INTRODUCING TECH4RAIL:
SEIZING AND DEVELOPING NEW TECHNOLOGIES STARTS HERE

Artificial intelligence	Energy storage	3D printing	Robotics
Automation	Lighter materials	Man-machine interfaces	Geolocalization

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DIGITIZE & AUTOMATE
TECH4RAIL HAS 3 MAIN PRIORITIES

(RE)INVENT THE RAIL SYSTEM OF THE FUTURE

Work with European partners to **validate new technological building blocks**: AI-assisted operations; budget-conscious, digitized infrastructure; advanced geolocalization of trains

CO-DEVELOP AN AUTOMATED TRAIN

The train of the future will be **more connected, more automated, and more eco-friendly**—capable of delivering more traffic, more flexibility, more on-time arrivals and more energy-efficient operation.
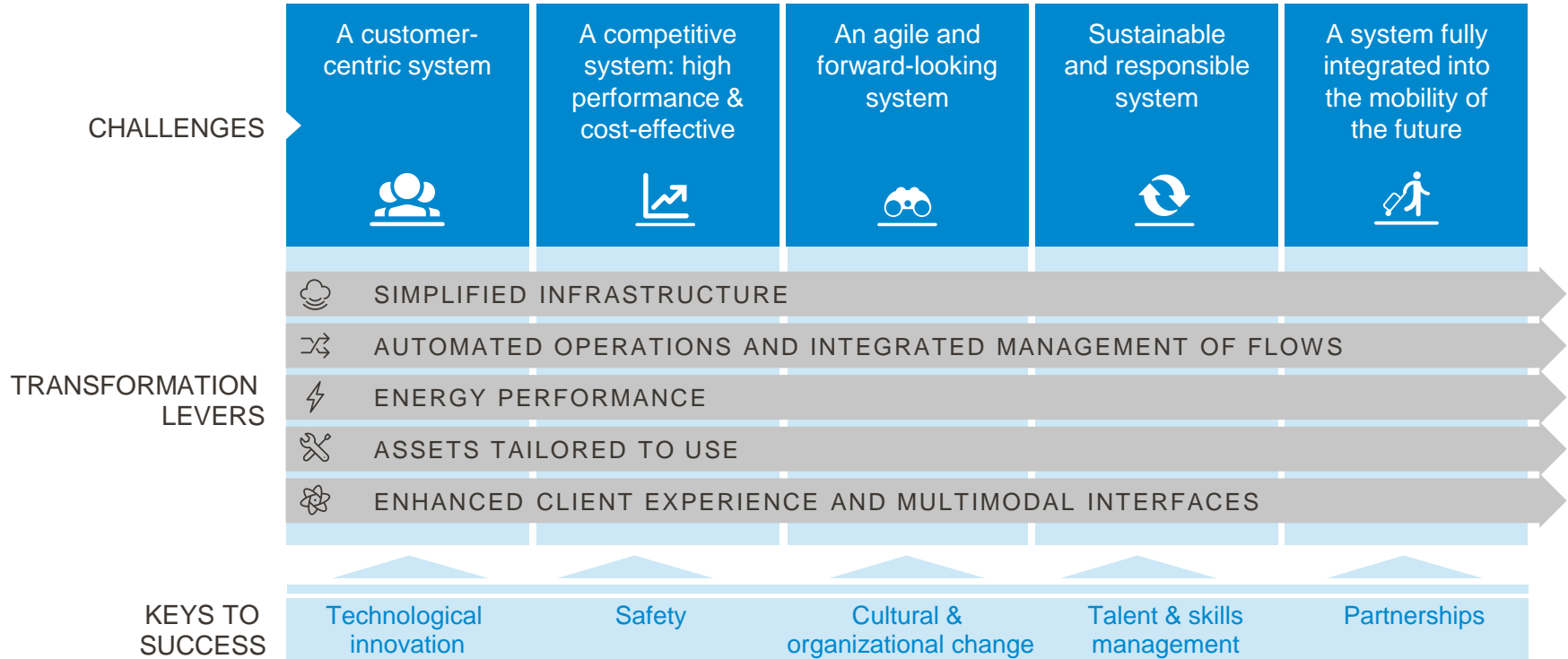

INVENT TOMORROW'S MOBILITIES

Build on our existing know-how (passenger experience, complex systems operation, safety and more) to position **SNCF as a champion of new mobilities**
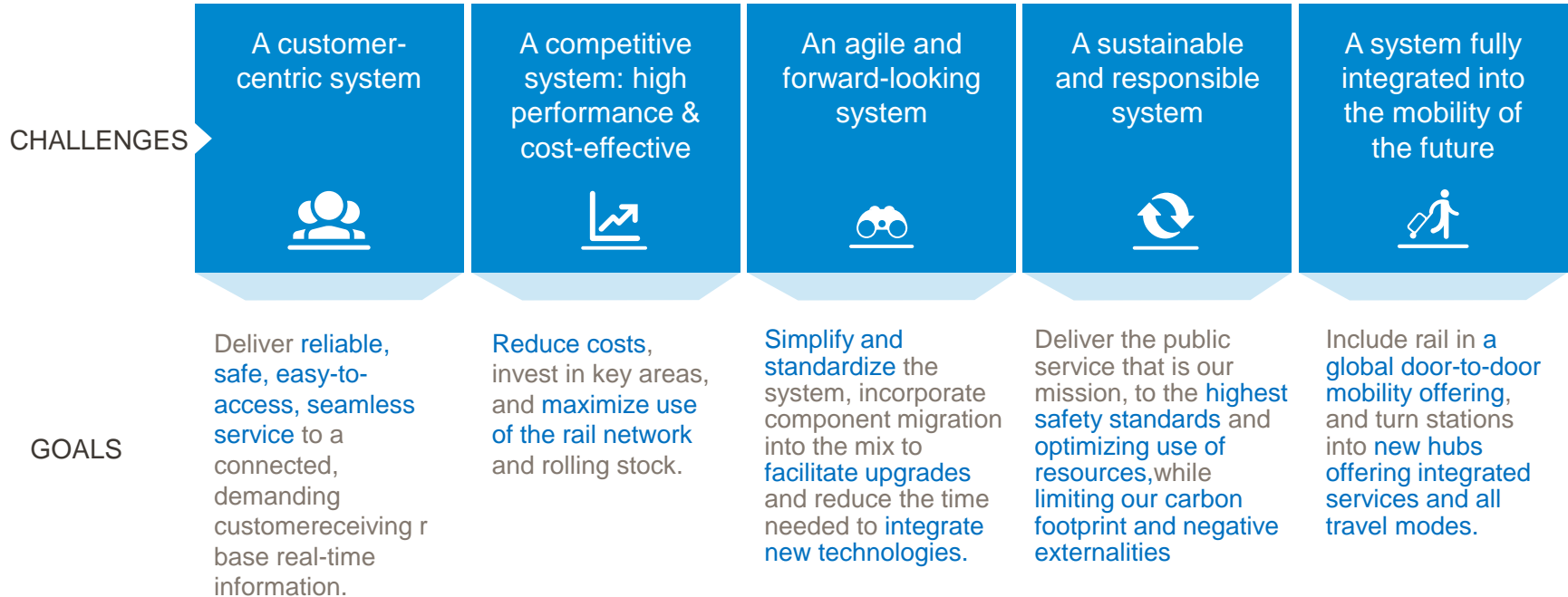
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OUR GLOBAL VISION

At SNCF, we're developing our vision of the railway system of the future as a means of identifying main priorities for cooperation with stakeholders across Europe.

CHALLENGES	A customer-centric system	A competitive system: high performance & cost-effective	An agile and forward-looking system	Sustainable and responsible system	A system fully integrated into the mobility of the future

TRANSFORMATION LEVERS

- SIMPLIFIED INFRASTRUCTURE
- AUTOMATED OPERATIONS AND INTEGRATED MANAGEMENT OF FLOWS
- ENERGY PERFORMANCE
- ASSETS TAILORED TO USE
- ENHANCED CLIENT EXPERIENCE AND MULTIMODAL INTERFACES

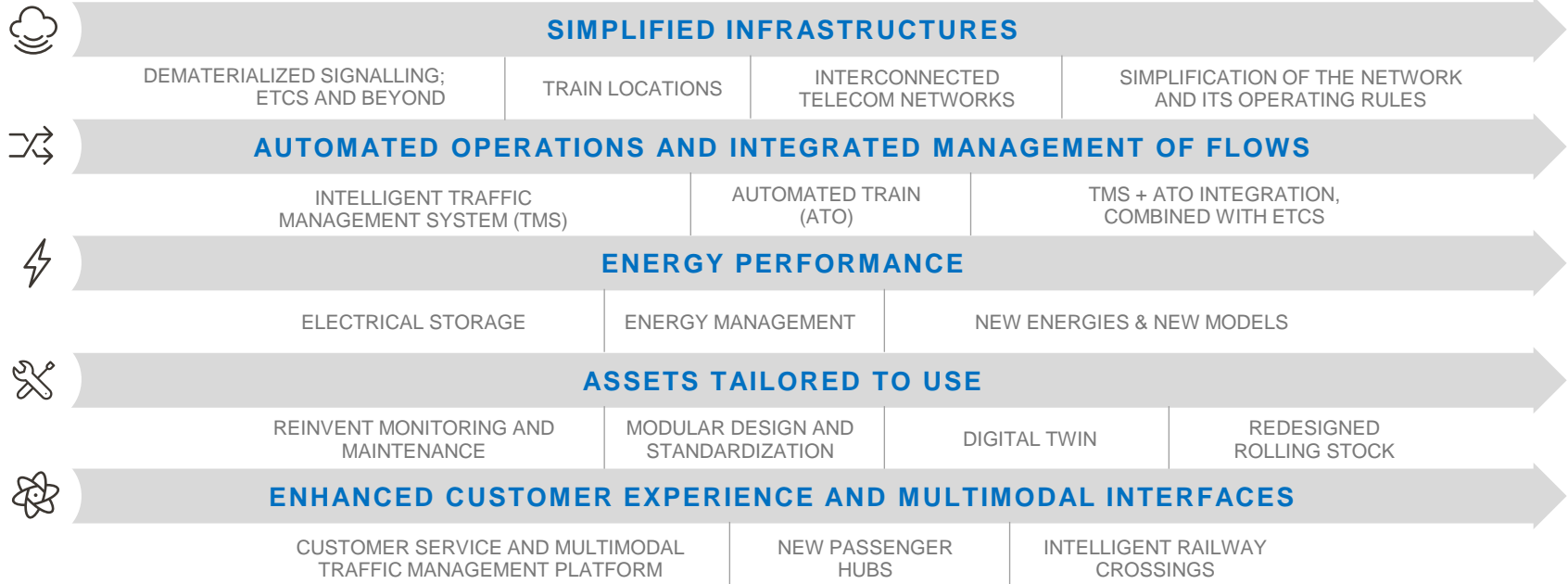| KEYS TO SUCCESS	Technological innovation	Safety	Cultural & organizational change	Talent & skills management	Partnerships

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CHALLENGES AND GOALS

BY 2030-2040, OFFER OUR CUSTOMERS A COMPETITIVE, AGILE, SUSTAINABLE RAILWAY SYSTEM THAT IS FULLY INTEGRATED INTO TOMORROW'S MOBILITIES

CHALLENGES

| A customer-centric system | A competitive system: high performance & cost-effective | An agile and forward-looking system | A sustainable and responsible system | A system fully integrated into the mobility of the future |

GOALS

Deliver reliable, safe, easy-to-access, seamless service to a connected, demanding customereceiving r base real-time information.

Reduce costs, invest in key areas, and maximize use of the rail network and rolling stock.

Simplify and standardize the system, incorporate component migration into the mix to facilitate upgrades and reduce the time needed to integrate new technologies.

Deliver the public service that is our mission, to the highest safety standards and optimizing use of resources,while limiting our carbon footprint and negative externalities

Include rail in a global door-to-door mobility offering, and turn stations into new hubs offering integrated services and all travel modes.

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TRANSFORMATION LEVERS

FIVE TRANSFORMATION LEVERS DEFINE THE TECHNOLOGY PATH TO OUR GOAL

SIMPLIFIED INFRASTRUCTURES

| DEMATERIALIZED SIGNALLING; ETCS AND BEYOND | TRAIN LOCATIONS | INTERCONNECTED TELECOM NETWORKS | SIMPLIFICATION OF THE NETWORK AND ITS OPERATING RULES |

AUTOMATED OPERATIONS AND INTEGRATED MANAGEMENT OF FLOWS

| INTELLIGENT TRAFFIC MANAGEMENT SYSTEM (TMS) | AUTOMATED TRAIN (ATO) | TMS + ATO INTEGRATION, COMBINED WITH ETCS |

ENERGY PERFORMANCE

| ELECTRICAL STORAGE | ENERGY MANAGEMENT | NEW ENERGIES & NEW MODELS |

ASSETS TAILORED TO USE

| REINVENT MONITORING AND MAINTENANCE | MODULAR DESIGN AND STANDARDIZATION | DIGITAL TWIN | REDESIGNED ROLLING STOCK |

ENHANCED CUSTOMER EXPERIENCE AND MULTIMODAL INTERFACES

| CUSTOMER SERVICE AND MULTIMODAL TRAFFIC MANAGEMENT PLATFORM | NEW PASSENGER HUBS | INTELLIGENT RAILWAY CROSSINGS |

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1ST LEVER

SIMPLIFIED INFRASTRUCTURES

Dematerialized signalling: ETCS and beyond

▶ Accelerate deployment of ETCS L2 / L2+ / L3 in economically sustainable conditions and explore additional gains in capacity through more widespread dematerialization

Technological building blocks: ETCS, IT, virtual coupling, computing power

2 essential blocks

Train location

▶ Develop train location and integrity solutions: safe, reliable, accurate, autonomous and real time

Technological building blocks: GNSS, inertial units, hybrid sensors

Interconnected telecom networks

▶ Integrate a set of reliable, robust and powerful interconnected telecommunication networks so that all connected systems and objects can communicate

Technological building blocks: IP, 4G/5G, V2X/C-V2X protocols

Simplification of the network and its operating rules

▶ Adopt simpler network and operating rules across the system, in particular at railway junctions

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2ND LEVER

AUTOMATED OPERATIONS AND INTEGRATED MANAGEMENT OF FLOWS

Intelligent Traffic Management System (TMS)

▶ Develop full assessment of situations in real time, and provide predictive decision-support tools for flow management—both trains and passengers

Technological building blocks:
Big Data processing, Artificial Intelligence, cognitive tools

Automated train operation (ATO)

▶ Create prototypes, then move up to full-scale production of automation blocks from GoA2 to GoA4 to increase capacity (assuming constant infrastructure), security/safety, flexibility and on-time arrivals.

Technological building blocks: detection, artificial intelligence, localization, safety demonstration

ATO + TMS integration, combined with ETCS

▶ Integrate those 3 key items (ATO+TMS+ETCS) to reach the full potential of each

Technological building blocks: distributed / centralized intelligence, computing, telecommunications

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PERFORMANCE LEAPS AHEAD THANKS TO THE AUTOMATED TRAIN

+ MORE TRAINS IN CIRCULATION

+ MORE ON-TIME ARRIVALS

+ MORE FLEXIBILITY

+ ENERGY SAVINGS

[SÉCURITÉ]

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FIRST STEPS & ACHIEVEMENTS IN ALL BUSINESS AREAS

TGV 2020 COMMERCIAL SERVICE

GOA1	**GOA2**	GOA3	GOA4

PROTOTYPE—FREIGHT

LONG-DISTANCE CONVOY

GOA1	GOA2	**GOA3**	**GOA4**

REMOTE DRIVER

GOA1	GOA2	GOA3	GOA4

PROTOTYPE— PASSENGER SERVICE

GOA1	GOA2	**GOA3**	**GOA4**

TECHNICAL ADVANCES
(all activities)

GOA1	GOA2	GOA3	**GOA4**

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KEY DATES AHEAD—AUTOMATED TRAIN

TRANSILIEN
NEXTEO GOA 2

FRET
TÉLÉCONDUIT

FRET
GOA 4

TER
GOA 3 ET 4

TGV
GOA 2

CIRCULATIONS
TECHNIQUES
GOA 3 ET 4

LARGE-SCALE PRODUCTION — ROLL-OUT
PROTOTYPE — ROLL-OUT
PROTOTYPE — LARGE-SCALE PRODUCTION — ROLL-OUT
PROTOTYPE — LARGE-SCALE PRODUCTION — ROLL-OUT
PROTOTYPE — LARGE-SCALE PRODUCTION — ROLL-OUT
PROTOTYPE — LARGE-SCALE PRODUCTION — ROLL-OUT

2019 2020 2021 2022 2023 2024 2025 2026 •••

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3RD LEVER

ENERGY PERFORMANCE

Electrical storage

▶ Deploy power storage on and off trains to improve operational reliability at sustainable cost; reduce energy consumption; reduce CO_2 emissions; and improve comfort

Technological building blocks: hybridization, high power batteries

Energy management

▶ Provide flexibility to the rail electrical system to optimize energy costs—peak shaving and load levelling—and facilitate integration of power production systems

Technological building blocks: smart grids, storage, digital tools

New energy sources & models

▶ Stimulate the emergence of "green" hydrogen solutions to decarbonize non-electrified lines and, from a system perspective, open up new uses, particularly in other mobility systems

Technological building blocks: H2 production, safe integration issues

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4TH LEVER

ASSETS TAILORED TO USE

Reinvented monitoring and maintenance

▶ Automate real-time monitoring of asset condition for better responsiveness—specifically through predictive maintenance—and to improve safety

Technological building blocks:
IoT, big data, predictive models, new security methods

Modular design and standardization

▶ Make standardized, modular design the rule to accelerate technology migration and facilitate matching of supply and demand

Technological building blocks:
IMA (Integrated Modular Avionics)

Digital twin

▶ Digitize design and production processes and make greater use of simulation and virtual testing

Technological building blocks:
digitalization, simulation

Redesigned rolling stock

▶ Rethink rolling-stock architecture, performance and life cycle

Technological building blocks:
miniaturization, eco-design, acceleration/braking systems

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5TH LEVER

ENHANCED CUSTOMER EXPERIENCE AND MULTIMODAL INTERFACES

Customer service and multimodal traffic management platform

▶ **Develop integrated** multimodal traffic and service management **platforms** to better adjust to demand

Technological building blocks:
data processing, modelling, blockchain

New passenger hubs

▶ Redesign passenger hubs to **make travel easier and more seamless** for all passengers, by integrating **multimodality** and **new emerging autonomous modes** of transport

Technological building blocks:
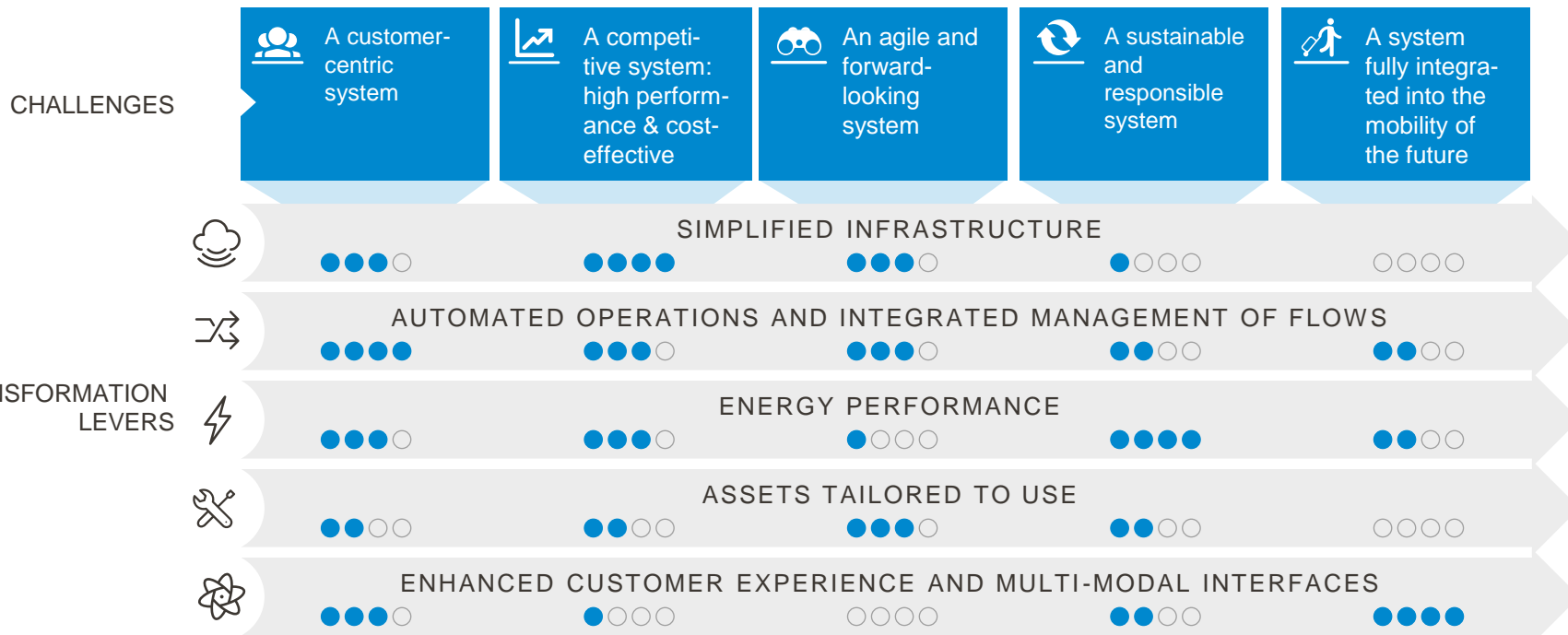flow simulation
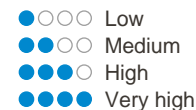
Intelligent railroad crossings

▶ **Transform level crossings into intelligent junctions that are "connected"** to vehicles on the road and to trains, for improved safety

Technological building blocks:
detection, IoT, 5G, V2X / C-V2X, location

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TRANSFORMATION LEVERS

IMPACT OF THESE FIVE LEVERS ON MAIN CHALLENGES

Legend:
- ●○○○ Low
- ●●○○ Medium
- ●●●○ High
- ●●●● Very high

CHALLENGES	A customer-centric system	A competitive system: high performance & cost-effective	An agile and forward-looking system	A sustainable and responsible system	A system fully integrated into the mobility of the future
TRANSFORMATION LEVERS					
SIMPLIFIED INFRASTRUCTURE	●●●○	●●●●	●●●○	●○○○	○○○○
AUTOMATED OPERATIONS AND INTEGRATED MANAGEMENT OF FLOWS	●●●●	●●●○	●●●○	●●○○	●●○○
ENERGY PERFORMANCE	●●●○	●●●○	●○○○	●●●●	●●○○
ASSETS TAILORED TO USE	●●○○	●●○○	●●●○	●●○○	○○○○
ENHANCED CUSTOMER EXPERIENCE AND MULTI-MODAL INTERFACES	●●●○	●○○○	○○○○	●●○○	●●●●

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KEYS TO SUCCESS
MUST BE DEPLOYED THROUGHOUT THE TRANSFORMATION PROCESS
TO ENSURE HIGH PERFORMANCE

TECHNOLOGICAL INNOVATION

DEVELOPMENT AND DEPLOYMENT OF NEW SAFETY METHODS

CULTURAL AND ORGANIZATIONAL TRANSITION

TALENT AND SKILLS MANAGEMENT
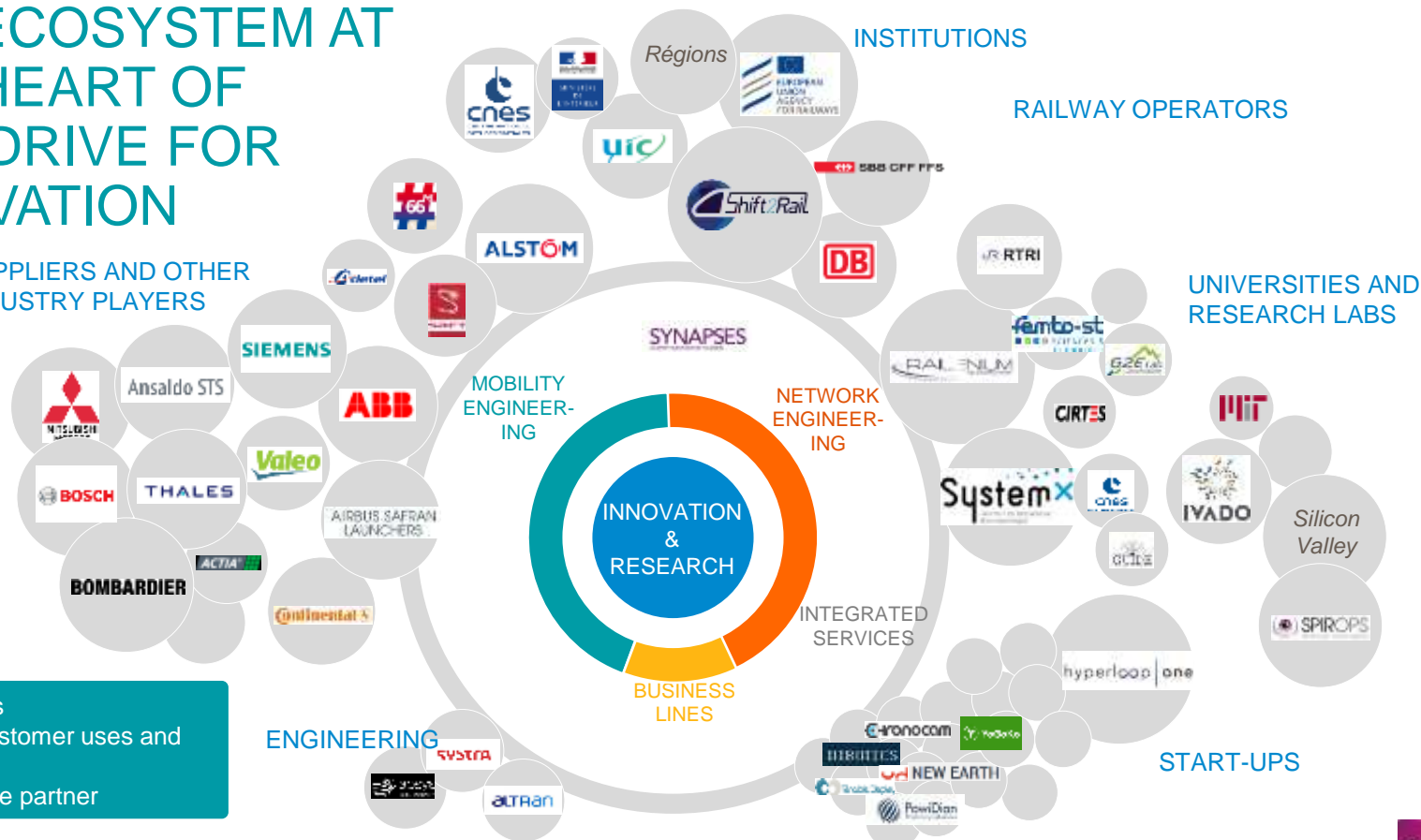
SUCCESSFUL PARTNERSHIPS

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THE ECOSYSTEM AT THE HEART OF OUR DRIVE FOR INNOVATION

INSTITUTIONS

Régions

RAILWAY OPERATORS

SUPPLIERS AND OTHER INDUSTRY PLAYERS

UNIVERSITIES AND RESEARCH LABS

MOBILITY ENGINEER-ING

NETWORK ENGINEER-ING

INNOVATION & RESEARCH

SYNAPSES

Silicon Valley

INTEGRATED SERVICES

BUSINESS LINES

ENGINEERING

START-UPS

> Rally inhouse teams
> Base projects on customer uses and expectations
> Become an attractive partner

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THANK YOU.

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www.sncf.com

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