Potential Large RTD Projects for RF–EU Cooperation

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1. Flight-test Investigation of Active Swept-wing Boundary Layer Laminarization and Turbulent Friction Drag Reduction

Tasks:	Investigation of the most prospective techniques of laminar-turbulent transition control and drag reduction in flight test.
Background:	Numerous active methods of transition delay and friction drag reduction were developed during last decades: discrete roughness elements, near-wall flow acceleration by DBD, close-loop control for TS waves cancellation, surface heating near leading edge, microjets, etc. Some of them were successfully tested in low-speed wind tunnels for relatively small Reynolds number. However, effectiveness of most of such methods crucially depends from Reynolds number, Mach number, ambient fluctuations level, atmospheric pressure and other factors which are different in flight conditions and wind-tunnels tests
Research directions:	Test will be conducted on the universal model of swept wing installed under the body of flying laboratory based on Su-30 airplane. Tests for transonic and supersonic speed in Reynolds number range 10—21 millions are planned.

2. Active usage of Structures' Elastic Features to Control the Loads, Vibrations and Aircraft Adjustment to the Flight Modes

Tasks:

To increase the competitiveness of perspective aircraft by improving flight characteristics, load-bearing unit weight reduction, noise level and fuel emission reduction, enhancing the reliability and safety based on the strength & aero elasticity parameters

Background:

- Active control of lifting surfaces' airfoil shape by adaptive, "smart" structures of high-lift devices
- Active and rational deformation of the local twisting angles and bendings as well as the lifting surface caissons' local deformation with in-built system of nondestructive control
- Applying the innovative control systems for active control of the aerodynamic quality, loads, flutter rejection, improving the control efficiency
- Development of the multidisciplinary and multilevel methodology and instruments of experiment-calculated methods for solving the active aero elasticity problems
- Design and manufacturing of the technologies' demonstrators, experimental investigation and its computational support

2. Active usage of Structures' Elastic Features to Control the Loads, Vibrations and Aircraft Adjustment to the Flight Modes

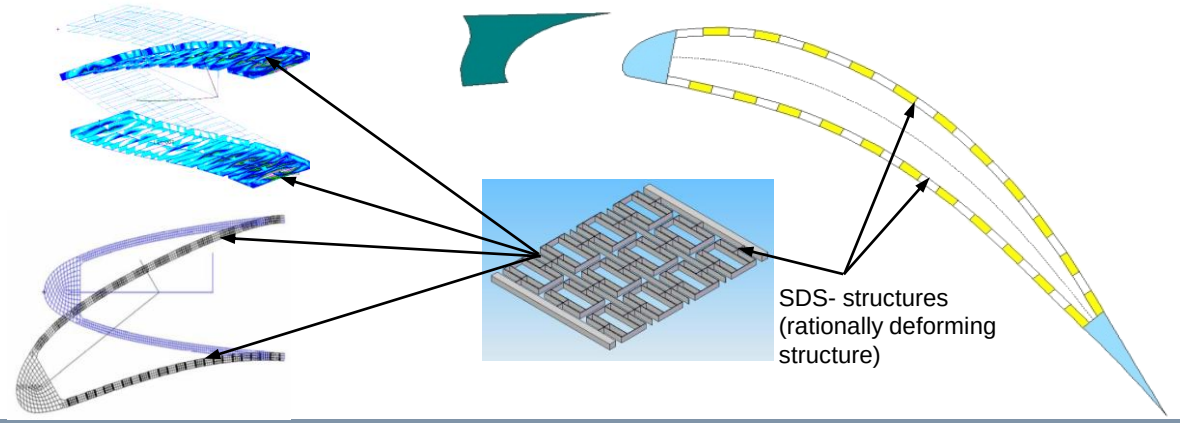
Research directions:

- *Development of the high-lift devices' adaptive elements for lifting surfaces*

Design of the adaptive fore and back edges, covers (spoilers-rudders), wings, rotor blades to improve the aerodynamic quality, noise & vibrations reduction, improving passengers' comfort. Participation in production of technologies' demonstrators, experimental investigation and computational support

- *Development of the active aero elasticity concept.*

Development of the control surfaces which use the structure elasticity (including piezo actuators) to enhance the aircraft control system efficiency, to reduce the aerodynamics loads, the level of vibrations and to decrease flutter critical speed. Participation in producing technologies' demonstrators, experimental investigation and computational support



3. Aerial Refueling of Commercial Aircraft

Tasks:

- Aircraft cost reduction (by its weight decreasing, changing its type to a lower one and increasing the number of variations.
- Reducing the fuel consumption.
- Reducing the pollution of atmosphere by fuel emissions.

Results:

- Aircraft fleet cost reduction by aircraft weight reducing, changing its type to a lower one and increasing the number of its production as well as decreasing expenses for pax⁄kilometer ratio).
- Noise level reduction in the airport area by decreasing the weight of long-range aircraft. Emissions reduction.
- Improving the mobility of aero units and fast response methods as well as international rescue units while fighting anthropogenic and natural disasters.
- Commercial use of military runways and refueling aircraft.
- Solving the problem of long-distance flight by supersonic commercial & business aircraft.
- Providing the possibility for any business or commercial aircraft to fly unlimited distance.

3. Aerial Refueling of Commercial Aircraft

Research directions:

- Development of the safe methods of in-flight refueling.
- Development of the certification methods for in-flight refueling.
- Solving the set of the problems related to aircrafts docking modes automation as well. as to approach process and flying in line while refueling.
- Development of the models which simulate refueling devices set.
- Navigation systems modernization for supporting refueling via 4D navigation.
- Development of the simulators for airlines.

4. General Aviation Safety and Efficiency Improvement by the Means of Control System "Light" and Inexpensive Automation

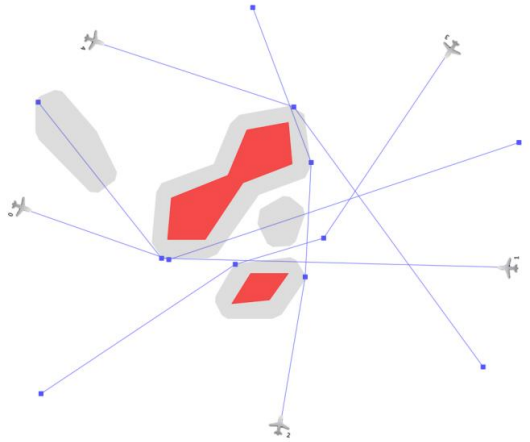
Tasks:	Development of the concept of «light» and inexpensive automation of control system Development of the control system automatic functions to increase safety and accuracy of the trajectory Introduction of novel technologies based on introduction of automation: cabin comfort improvement system, pilot monitoring system, use of ground effect, air refueling
Background:	National projects
Addressed VISION 2020 goals:	➢ Increasing passenger choice ➢ Reduction in accident rate by 80%, Reduction in human error and its consequences; ➢ To enable the Air Transport System to accommodate 3 times more aircraft movements by 2020 compared with 2000
Expected results:	Concept of general aviation control system automation Control system general algorithms Virtual technology demonstrator

5. Flight Safety and Efficiency Improvement by the Means of Control System Automation and Optimal "Pilot-aircraft" Interaction

Tasks:	Development of advanced flight control system with enhanced safety protection functionality Development of optimal distribution of functions between crew and control system Cockpit operations optimization
Background:	➢ National projects ➢ Participation in European projects SUPRA, ARISTOTEL, FLYSAFE,…
Addressed VISION 2020 goals:	➢ Reduction in accident rate ➢ Reduction in human error and its consequences ➢ To enable the Air Transport System to accommodate 3 times more aircraft movements by 2020 compared with 2000
Expected results:	➢ Principles of crew-aircraft information interaction for highly-automated aircraft ➢ Concept and principles of highly automated aircraft control system ➢ Virtual technology demonstrator

6. Development of Collaborative Decision Making Technologies to Improve Flights Safety and Efficiency

Tasks:	Development of the concept of collaborative decision making system maximizing overall ATS performance Development of the algorithms for flight situation assessment and optimal trajectories generation Development of requirements to system performance and data links
Background:	➢ National projects ➢ Participation in European projects ALICIA, 4DCoGC FLYSAFE,…
Addressed VISION 2020 goals:	➢ Reduction in accident rate ➢ To reduce fuel consumption ➢ Reduction in human error and its consequences ➢ To enable the Air Transport System to accommodate 3 times more aircraft movements by 2020 compared with 2000
Expected results:	➢ Concept of collaborative decision making system ➢ Requirements to system performance and data links ➢ Algorithms of situations assessment and collaborative decision making



7. Development of Seamless Airport Technologies with use of 4D Contracts Principles

Tasks:	Development of the concept of advanced airport complex Development of innovative technologies targeted at airport operations efficiency improvement (catapult take-off, ground 4D contracts, use of GALILEO/GLONASS technologies) Selection of advanced technical solutions and simulation
Background:	➢ National projects ➢ Participation in European projects ALICIA, 4DCoGC
Addressed VISION 2020 goals:	➢ Reduction in accident rate ➢ To reduce fuel consumption ➢ Reduction in human error and its consequences ➢ To enable the Air Transport System to accommodate 3 times more aircraft movements by 2020 compared with 2000 ➢ To reduce the time spent by passengers in airports to under 15 minutes for short-haul flights and to under 30 minutes for longhaul, to enable 99% of flights to arrive and depart within 15 minutes of their advertised scheduled departure time, in all weather conditions
Expected results:	Concept of advanced airport complex Proposals on global optimization of airport operations by «seamless» interaction of it's elements with use of 4D contract principles

8. Integration of UAV in Single Airspace

Tasks:

Development of requirements for UAV usage in single airspace
Study of innovative configurations of micro- and mini- UAV
Development of requirements for "ground operator — UAV" interaction
Development of requirements for organizations responsible for design, manufacturing and maintenance of UAV

Background:

- National projects
- Cooperation with international organizations ICAO, JARUS, EASA, UAS International, EUROCAE

Addressed VISION 2020 goals:

- Transforming air freight services
- To reduce fuel consumption and CO_2 emissions by 50%
- Reduction of the accident rate by 80%
- Reduction in human error and its consequences
- To enable the Air Transport System to accommodate 3 times more aircraft movements by 2020 compared with 2000

Expected results:

Main principles and requirements for UAV usage in single airspace
Requirements for ground operator — UAV interaction
Requirements for organizations responsible for design, manufacturing and maintenance of UAV

9. Applying TVC for Improving Transport Aircraft Safety and Making It Greener

Purpose: Experimental demonstration of TVC performance features and technical possibility to apply TVC on civil transport aircraft

Tasks:

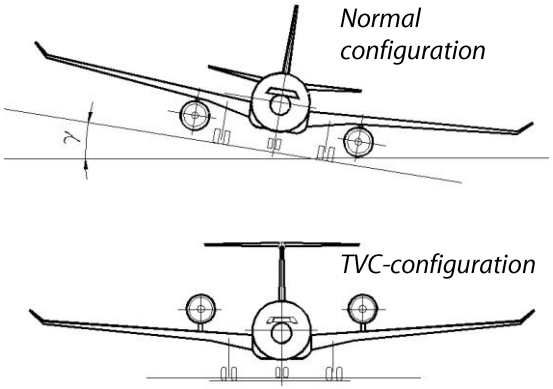
- Development of the variants and choosing the most appropriate configuration of jet nozzle capable to perform thrust vector change
- Providing intake safe performance in an untraditional propulsion system configuration and an aircraft with operating TVC
- Investigation of the area of aircraft flow with deflected TVC jets to ensure the flight safety
- Demonstrating the advantages of the TVC features as the forces direct control panel and as an additional control panel at critical flight modes and in failure situations
- Experimental comparison of the untraditional configuration aerodynamic features, chosen for TVC, with the transport aircraft of a normal configuration
- Evaluation of the additional loads occuring because of TVC. Note that these loads affect the propulsion system & aircraft strength
- Working out the trustworthy method of defining the noise coming from the jet flow across the outer aerodynamic flow on the basis of physical tests
- Integrating the technologies and defining the conception of the TVC aircraft on the basis of experimental data

9. Applying TVC for Improving Transport Aircraft Safety and Making It Greener

Research direction:

- Aerodynamic study of the TVC platform for civil aircraft
- Experiment-calculated study of the civil TVC aircraft's maneuverability by flight simulator
- Investigation of the TVC aircraft propulsion system features
- Investigation of the noise coming from the TVC aircraft
- Integrating the technologies and defining the conception of the TVC aircraft on the basis of experimental data

Applying TVC as a direct control unit for lateral force control to compensate the lateral wind while taking off & landing



10. Investigation of New Generation Aircraft's Concepts

Purpose:

To define the contribution of innovations in aerodynamics, propulsion systems, materials, structures, avionics into the efficiency of the civil aircraft of different types

To analyze the basic technologies' maturity which lies in the core of the innovations

To define the concepts of 2020, 2030 & 2050 novel aircraft

Tasks:

- Analysis of possible innovations in aerodynamics, propulsion systems, materials, structures, avionics & systems.
- Investigation of the innovations' application efficiency at the lifecycle stages of the perspective aircraft:
  - long-haul aircraft
  - regional & business jet
  - small aviation aircraft
- Analysis of the basic technologies' degree of availability, risk-analysis of innovations implementation
- Innovations realizeability confirmation on the basis of technologies' demonstrators including flight tests

10. Investigation of New Generation Aircraft's Concepts

Expected results:

- Definition of the market needs and the most important factors of competitiveness of the next gen aircraft
- Development of the technical concepts for reaching aircraft perfection on the basis of multifactor and multidisciplinary analysis
- Performing calculation, engineering and technological works to provide the data for experimental and test-bench investigations on aerodynamics, strength, aero acoustics and control systems
- Evaluation of the realizeability of novel aircraft concepts
- Creating the demonstrators and performing full-scale simulation to confirm the operability of the basic technologies key elements

11. Improvement of the Methods of the Airship's Appearance, Airframe, Balancers and Control System Aerodynamic Design

Purpose: To ensure the trustworthiness of airship's aerodynamic and dynamics features at early stages of its design to provide the optimal airframe shapes and geometrical features of balancing and control systems

Tasks:

- Analysis of global airship building tendencies to choose the most perspective configuration of aerostatic aircrafts' airframe, its balancing and control systems as typical configurations. It would let work out prompt methods of airships' aerodynamic & dynamic features and its assessment
- Adjustment of algorithms which allow to calculate the aerodynamic features of typical airships' configuration
- Performing constant calculations of typical configurations' aerodynamics by commercial software
- Existing experimental data analysis to ensure its integrity and suitability for verifying the results of typical configurations' calculations
- Choosing the most popular configuration among the new ones, but for which existing experimental data bank is insufficient, its model production and gaining missed data by wind tunnel tests
- Comparing the results of the airships' typical configuration calculations with the experimental data to define the range of the flight kinematic parameters for which modern calculation methods provide appropriate results. As well this is to define the ranges for which it's possible and needed to work out experimental corrections for computational parameters. This method is also valid for ranges for which only experimentally gained parameters can be used

11. Improvement of the Methods of the Airship's Appearance, Airframe, Balancers and Control System Aerodynamic Design

Research direction:

- Working out the methods of defining experimental corrections to computational characteristics
- Working out ways of acquiring the descriptions of features which can't be calculated by commercial software
- Working out the equations of vehicle dimensional movement and software for multi parametric solution of these equations. They are required for defining the necessary level of maneuverability, stability and giving recommendations on changing the stabilizers and control surfaces' efficiency

12. Investigating the Possibility of Sonic Boom and Noise Reduction for Perspective Transport Supersonic Aircraft while Taking Off & Landing

Purpose:

Task:

- Numerical simulating of processes in gas dynamics, strength & acoustics
- Novel engineering solutions in aerodynamic design, propulsion systems, perspective structural materials application and engineering solutions while developing the structural elements & propulsion system design of the supersonic business jet and supersonic transport aircraft
- Computational and full-scale assessment of the noise level at engines' various operational modes while jets shielding by airframe elements on the ground
  (ground tests without fore wheel taking off are acceptable
- Computational evaluation and full-scale measurements of the sonic boom at aircraft's various flight modes.

Background:

Research direction:

13. Investigation of Advanced Flying Vehicles Power Plant Integration, Including Technologies for Creation and Investigation of Their Components

Task:

- Investigation of architecture, structural features and integration of power plants with different schemes (open rotor, distributed power plants, electrical engine, engine with ultra-high bypass ratio, engine for supersonic business jet, APU based on fuel cells operating on hydrocarbon fuel)
- Tests of model fans, compressors and combustors and their components in real and semi-real conditions

Background:

- Experience of similar problems solution in frames of national program
- Participation in European projects VITAL, DREAM, HISAC, etc

Addressed VISION 2020 goals:

- 50% cut in CO_2 emissions
- Reducing noise level
- Five-fold reduction in accidents
- Competitive supply chain
- Reducing travel charges

Expected results:

- Engine architecture of different function flying vehicle will be optimized
- Various structural — schematic solutions will be checked and tested

14. Development and Investigation of Active Methods for Management of Unsteady Processes in Order to Lower Emissions and Noise and Extend Engine Stability Margins

Task:

- Development of complete simulation methods for noise inception, propagation and absorption processes
- Development of active methods for lowering noise generated by aviation engines
- Development of effective methods for lowering emission of aviation engines
- Development of flow management devices

Background:

- Development of software to investigate acoustic processes
- Development and investigation of effective sound adsorbing devices
- Development of software to simulate kinetic processes
- Development of devices for combustion augmentation

Addressed VISION 2020 goals:

- 50% cut in CO_2 emissions
- Reducing noise level
- Five-fold reduction in accidents

Expected results: Development of active devices to manage processes in aviation engines

15. Provision of Safety and Reliability of Flying Vehicle Engines and Lowering of Operational Costs

Task:

- Development of methods for strength and reliability problem investigation of assemblies from advanced materials
- Development of technologies for manufacturing engine details using advanced metallic and nonmetallic materials
- Development of methods and systems to diagnose condition of engine assemblies

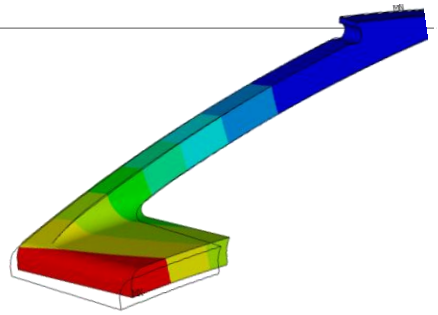
Background:

- Experience of similar problems solution in frames of national program
- Cooperation with leading Russian scientific organizations

Addressed VISION 2020 goals:

- 50% cut in CO_2 emissions
- Competitive supply chain
- Reducing travel charges
- Increase of safety

Expected results:



16. Creation of Automatic Traffic Management Beyond SESAR

Task:

- Development of application of satellite repeaters(including the existent Russian group) of signals of ADN-B 1090ES for transformation and transmission of dataflow along with traditional communication channels
- Creation of the single (continental) up-diffused interactive model of air space in interests the integral evaluation of current status of air space and its prognosis on the criteria of safety and efficiency
- Integration of pilotless aircrafts in the single European aviation transport system
- Conditioning for the mass use of personal aircrafts : realization a directive management, routing and providing of safety, below than lower echelon
- Creation on the basis of ADN-B technology of the motor-car systems preventing frontal collisions on the closed areas of roads

Background:

- Experience of similar problems solution in frames of national program

16. Creation of Automatic Traffic Management Beyond SESAR

Addressed VISION 2020 goals:

- Flight arrive within one minute of the planned arrival time
- Traffic provides 25 million flights a year of all vehicles
- The whole European aviation industry is strongly competitive
- Ensuring less than 1 accident per 10 million commercial aircraft flights
- Weather and other hazards are properly mitigated
- The European air transport system operates through interoperable
- Air vehicle are resilient by design to current and predicted threat evolution
- The air transport system is resilient by design to cyber attacks

Expected results:

- Use of the most progressive and again nascent technologies for perfection of the use of single air space of the Eurasian continent and the Earth on the whole

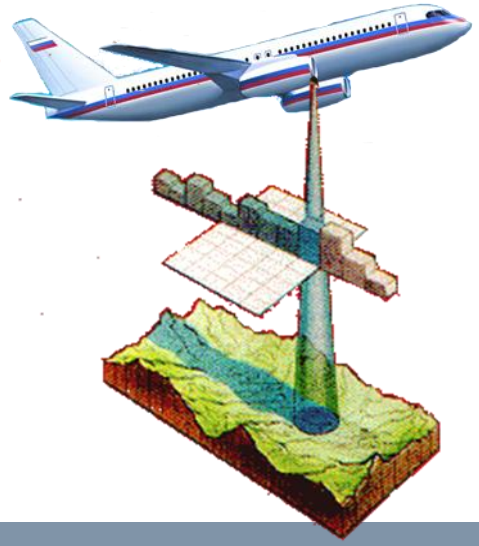
17. Development and Investigation of Methods for Creation and Manufacturing Vehicle Navigation Systems with the Aid of the Earth Physical Fields

Task:	➢ Creation of high-fidelity airborne sensors of height of relief, anomalous gravitational field, field of radio thermal contrast ➢ Creation of effective technology of preparation of the standard cartographic providing on the different geophysical fields ➢ Decision of problems of integration for navigational systems using the different geophysical fields
Background:	➢ Experience of similar problems solution in frames of national program
Addressed VISION 2020 goals:	➢ Flight arrive within one minute of the planned arrival time ➢ Traffic provides 25 million flights a year of all vehicles ➢ The whole European aviation industry is strongly competitive ➢ Europe will maintain leading-edge design… and jobs ➢ Design and upgrade processes addressed decreased costs ➢ Weather and other hazards are properly mitigated ➢ The European air transport system operates through interoperable ➢ The air transport system is resilient by design to cyber attacks

17. Development and Investigation of Methods for Creation and Manufacturing Vehicle Navigation Systems with the Aid of the Earth Physical Fields

Expected results:

	Relief	**Gravitational field**	**Radio thermal contrast**
Accuracy	30 – 100 м	300 – 3000 м	50 – 100 м
Autonomy	Yes	Yes	Yes
Disclosure	Minor	Absent	Absent
Noise immunity	High	High	High
Zone of action	Dry land with informing relief	Earth on the whole	Dry land with contrasting objects



18. Development and Investigation of Methods for Creation and Manufacturing Zero Maintenance Equipment for Aviation

Task:

- Creation of fault-tolerant calculating environment with the operational redundancy and deployment specialized highly-integrated chips
- Development of technologies for providing of element wise (at the level of the modules and their parts) redundancy of airborne equipment
- Creation of the high-performance systems of collection and treatment of information about a airborne equipment for an analysis in real time(during flight and on taxi tracks)
- Development and realization of highly developed algorithms for localization of the directly controlled and out-of-control failures (at presence of and absence of facilities of built-in control)
- Development and realization of algorithms of deep(at the level of the modules and their parts) reconfiguration of the airborne systems

Background:

- Experience of similar problems solution in frames of national program

18. Development and Investigation of Methods for Creation and Manufacturing Zero Maintenance Equipment for Aviation

Addressed VISION 2020 goals:

- Flight arrive within one minute of the planned arrival time
- Traffic provides 25 million flights a year of all vehicles
- The whole European aviation industry is strongly competitive
- Europe will maintain leading-edge design… and jobs
- Design, upgrade and maintenance* processes addressed decreased costs
- Ensuring less than 1 accident per 10 million commercial aircraft flights
- Air vehicle are resilient by design to current and predicted threat evolution

Expected results:

- Achievement of self-repair for airborne equipment in interrepair period
- Radical reduction of time and cost of service
- Achievement maximum of possible reliability and safety indexes

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- Development and realization of highly developed algorithms for localization of the directly controlled and out-of-control failures (at presence of and absence of facilities of built-in control) with using the system of distribution sensors and with the new functions of automatic diagnostic of failures on the basis of information-logical and mathematical models
- Development and realization of algorithms of deep(at the level of the modules and their parts) reconfiguration of the airborne systems

Background:

- Experience of similar problems solution in frames of national program

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19. Development of technologies of creation of board equipment for fully electrified aircraft (FEA)

Task:

- Substantiation of the appearance of the electric power complex FEA
- Creation of the adaptive fault-tolerant structures of the power supply system including emergency and reserve systems
- Development of the system of distribution of electric power, including development of lightweight on-board wires and powerful contactless switching equipment with program control
- Development of the function of management of the electric power complex on the basis of IMA platform
- Development of power element base, sources and semiconductor converters with high power, and also the creation of necessary electro technical materials with the required characteristics
- Development of the effective board electro hydromechanical and electromechanical drives of the flight management systems of the aircraft and of the takeoff and landing devices
- Development of architecture and algorithmic support of the control system of aerodynamic surfaces and takeoff and landing devices with electromechanical drivers

Background:

- Experience of similar problems solution in frames of national program

19. Development of technologies of creation of board equipment for fully electrified aircraft (FEA)

Addressed VISION 2020 goals:	➢ Reduction of fuel consumption; ➢ Decrease of the weight of a construction and the cost of the plane; ➢ Reduction of costs and time for designing and operation; ➢ Improvement of the environmental conditions during operation; ➢ Simplification of the structure and increase of controllability of the onboard equipment
Expected results:	➢ Realization of the FEA concept will facilitate the further integration of on-Board equipment and significantly reduce the cost of its operation

20. Creation of self-contained automated design technologies and system integration of complex of onboard equipment with the support of the processes of testing and trials on the basis of the model-oriented approach

Tasks:	➢ Creation of integration complex of instruments witch is intended for automation of designing and system integration of avionics ➢ Automation of generation of test specifications and procedures on the basis of data, received during the use of automated technologies of complex of board equipment design ➢ Standardization and automation of descriptions for the information communication interfaces of complex of board equipment
Background:	➢ National projects
Addressed VISION 2020 goals:	➢ The reduction in the unit value of the life cycle of the aviation products ➢ Reduce of the development time of aviation technics at the expense of reduction of terms of the development of complex of board equipment and its certification ➢ Creation and introduction of new technologies of experimental investigations
Expected results:	➢ Creation of a unified complex of design for aircraft («virtual aircraft») ➢ Integration with the systems of automation of production and the operation of aircrafts ➢ Development of the library of the typical models and analysis tools for support of new technologies of computing and communication environments of complex of board equipment