Aviation System After Next

What innovations will be needed?

ATM Seminar 2000

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Planning for the Future

- Current U.S. R&D and collaborations with Eurocontrol address aviation needs to 2015-2020
  - the “Next Generation Aviation”
- Will planned improvements and ATM R&D accommodate traffic demands to 2020 or even to 2010?
  - If not, what innovations will be needed?

Planning for the Future

- If new innovations are required …..
  - Research and operational demonstrations could take 10 to 15 years (CTAS did)
  - Infrastructure and fleet upgrades/replacement could take 20 to 30 years
  - Revolutionary new vehicles/systems could take 30 years to become operational
  - Global, Multi-modal, environmentally compatible solutions are necessary
  - Safe/economically viable transition is mandatory

Planning for the Future

- **It's prudent to start R&D planning for Aviation Beyond 2020 now!**
  - **Establish bold vision of the future**
    - **Consider innovative, even revolutionary ideas**
  - **Identify transition paths to new system**
  - **Develop National/International priority for R&D**
    - **Continue R&D for evolutionary changes**
    - **Start long-term innovative systems research**
  - **If potential solutions found ….**
    - **Develop & demonstrate critical technologies**
    - **Perform necessary transition R&D**

Aviation 2020 to 2050

- Capable of supporting …
  - Cargo demand up 5 - 20 times (?)
  - Passenger demand up 2 - 10 times (?)
  - Personal air/road vehicles > 10^6
  - Seamless air/ground transportation
  - Time efficient from origin to destination
- Environmentally compatible
- Safe, secure and affordable

What Innovations?

- Automated flight & ATM with human oversight (?)
- Automated, airport independent cargo operations (?)
- Automated, airport independent personal road/air vehicles (?)
- Integrated/seamless air/ground mass transportation (?)

Example: Cargo Operations

- Air cargo fastest growing segment
  - Domestic & international growing at 5 % & 7% per year
  - E-commerce and just-in-time commerce fueling growth
- 80% of domestic air freight by all-cargo carriers (operate largely at night)
  - 1013 aircraft in 1999- growing at 6% per year
  - Noise restrictions limit growth of night operations
- One or more ground modes used to & from final destination/origination
  - Many manual and machine aided operations

Example: Cargo System

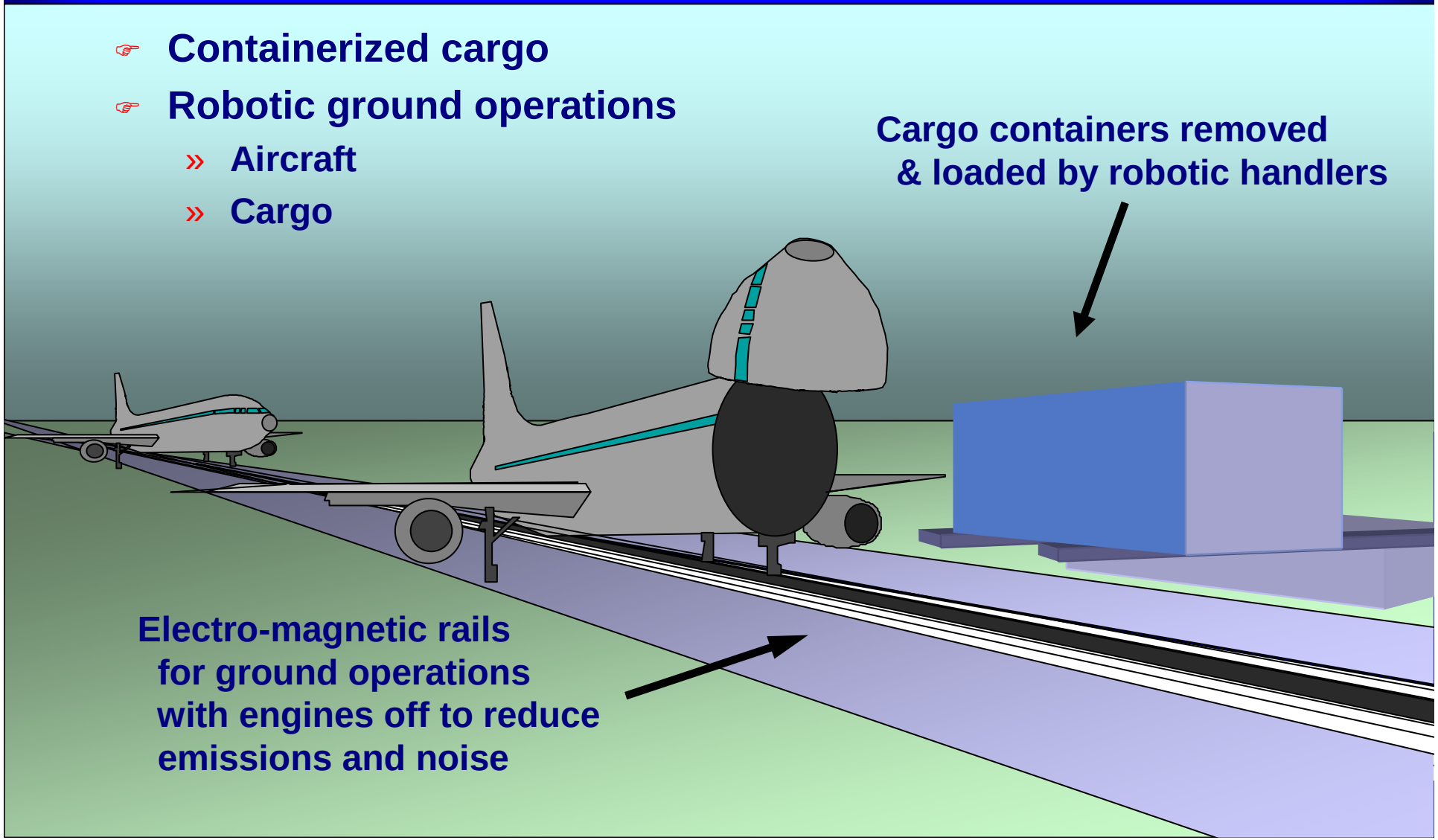
Opportunity: **Seamless, efficient cargo delivery from origin to destination**

Possible Solution: **Automated UAVs with electro-magnetic rail launch and recovery, automated traffic management, extreme noise abatement for airport independent operations and robotic ground handling**

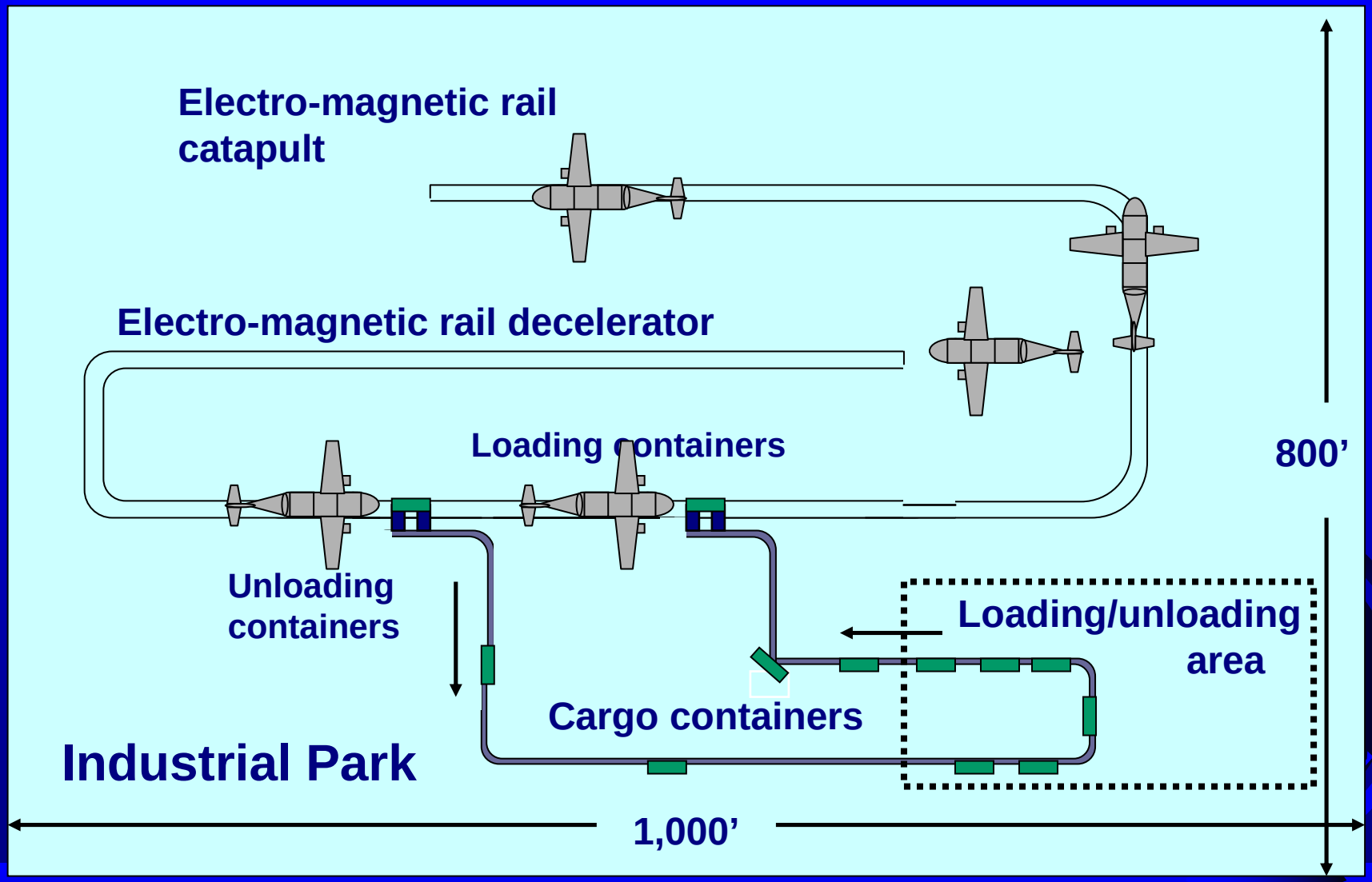
- **Uninhabited air vehicles (UAV) optimized for cargo operations using containers**
- **Catapult and arrestor system for short takeoff and landing**
- **Operate out of industrial parks, not airports**
  - **Cargo taken from origination to destination - bypassing trucks**
  - **Minimize cargo operations from congested airports**
- **Automated cargo airways separate from passenger traffic**

UAV Cargo System Example

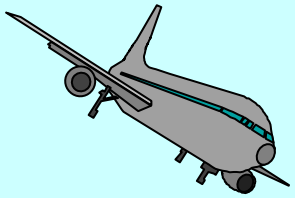
- Containerized cargo
- Robotic ground operations
  - Aircraft
  - Cargo



UAV Cargo System Example

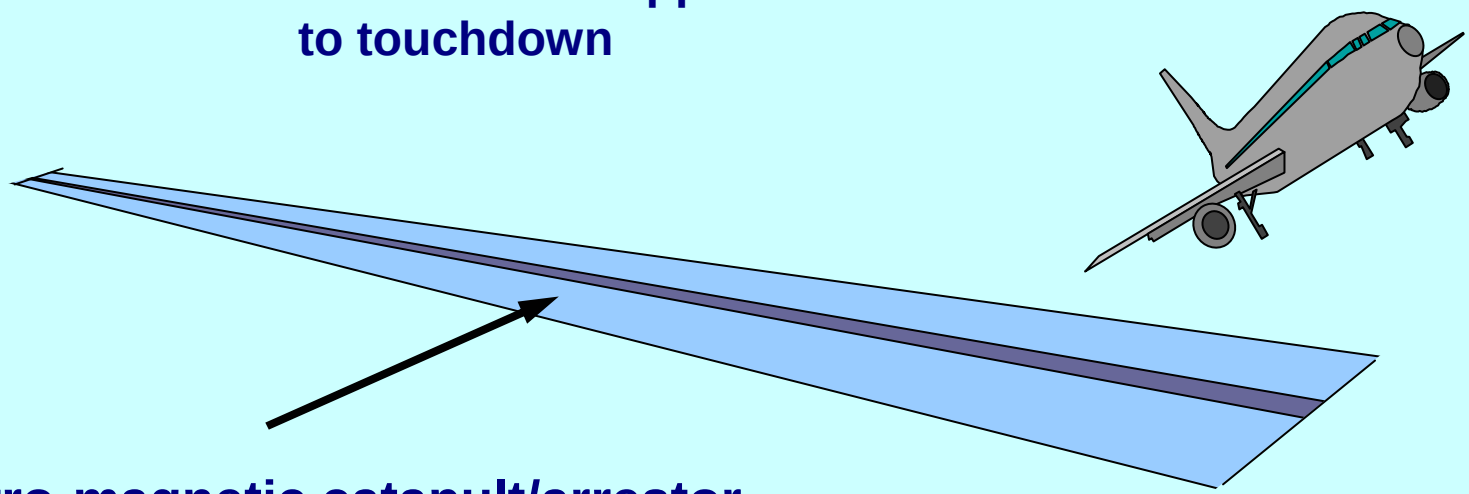


UAV Cargo System Example



Automatic landing
- 15^{o} approach angle & engines at idle for noise reduction
- Flare to 3^{o} final approach to touchdown

Noise abatement climb-out
- 3-g acceleration launch
- Automatic engine control synchronized with catapult



Electro-magnetic catapult/arrestor
- Flywheel capacitor charged during landing
- Discharged to power catapult

UAV Cargo System Example

- What critical technologies?
  - Automated ATM system for cargo UAVs
  - Unique cargo/container UAV system
    - High longitudinal “g” capability
  - Electro-magnetic assisted takeoff, arresting and ground operations
  - Automated noise abatement operations
  - Extremely high reliability & availability

UAV Cargo System Example

- Is this concept viable?
  - Technically?
  - Operationally?
  - Economically?
  - Acceptability?
- Don’t know!

….. but someone should be investigating these types of innovations for beyond 2020

Innovative Concepts R&D

- Human-centered automation system approach (air and ground)
  - Can it support future capacity demands?
- Automation-centered system approach
  - Are there possible solutions?
  - What role for humans?
- We need to investigate new concepts of operations and potential innovative systems solutions for beyond 2020